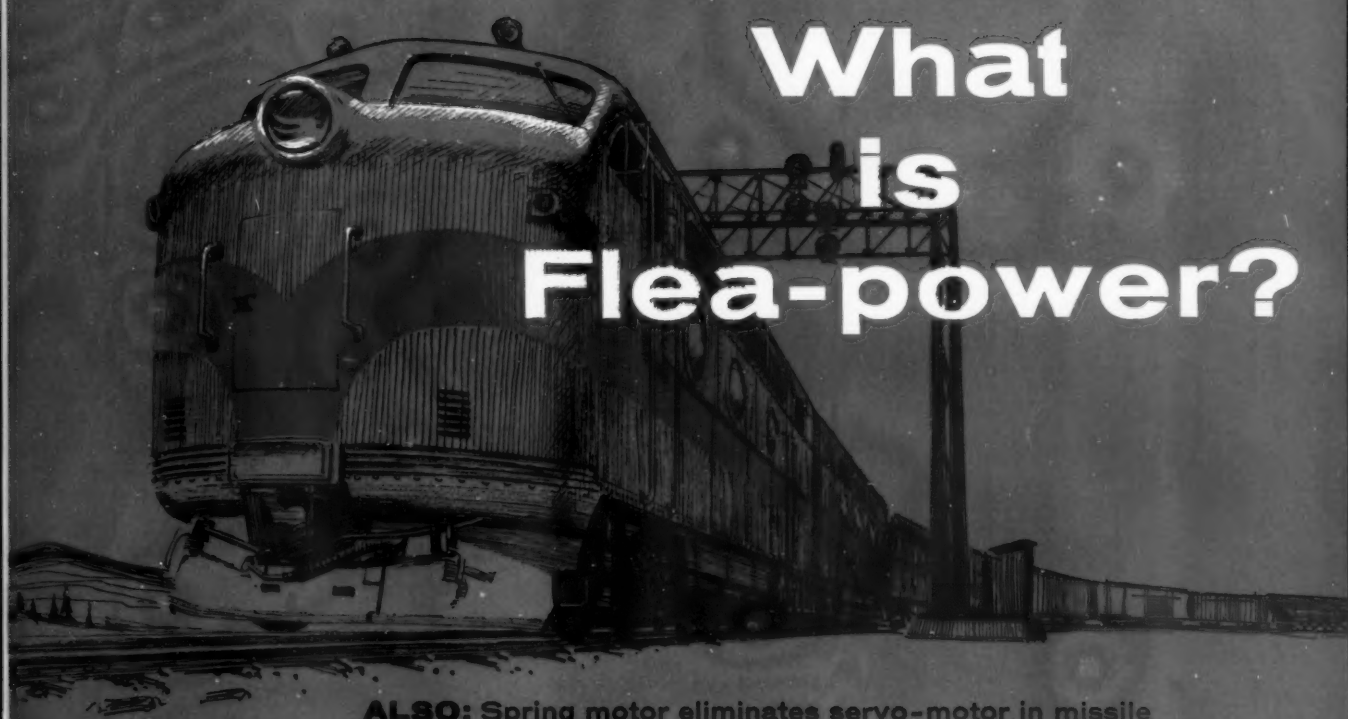
POWER TRANSMISSION DESIGN

Nationwide Survey on Gears, V-Belts, Roller-Chain

OEM · · MAINTENANCE

JULY 1959



What is Flea-power?

ALSO: Spring motor eliminates servo-motor in missile

M-g sets control bulk handling process

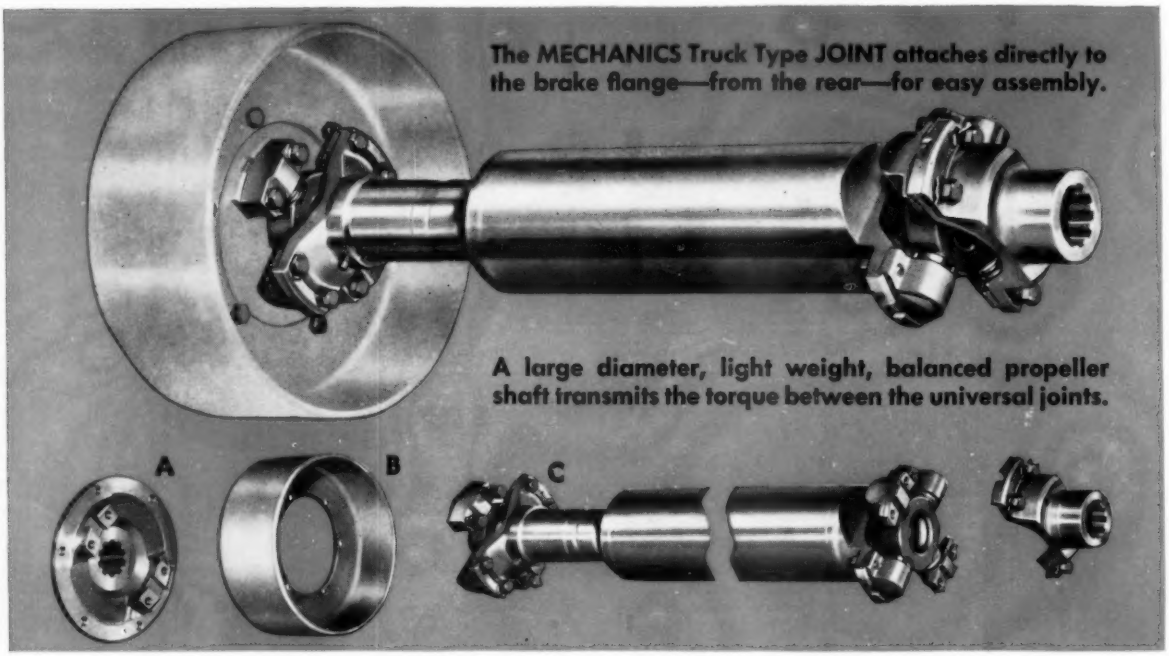
How to compute tolerance stack-up on gears and bearings

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

ALL Universal Joints - Are NOT Alike

MECHANICS Roller Bearing UNIVERSAL JOINTS for Trucks are specially designed with less parts and connections for *easy assembly* and *servicing* — *smooth running balance* — *maximum strength* with *less weight* — and *long, trouble-free, safe operation.*


The MECHANICS Truck Type JOINT attaches directly to the brake flange—from the rear—for easy assembly.
A large diameter, light weight, balanced propeller shaft transmits the torque between the universal joints.
A
B
C

MECHANICS Truck Type JOINTS are assembled by attaching joint C to brake flange A independent of fastening between drum B and flange A; making possible servicing drum or joint, without disturbing other attachments or altering original brake drum or propeller shaft balance. Let MECHANICS engineers help give *your* trucks or other heavy duty machines these competitive advantages.

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deliver more "giddap" per horse

You put more productive "giddap" into any machine when you install a Maurey V-Drive or a Maurey Roller Chain Drive. Maurey Drives deliver the full horsepower from the motor to the machine. It's a double advantage, to have Maurey drive engineering and the complete Maurey line at your disposal as you plan. For here, in one place, is the answer to the whole drive problem . . . engineering, the right pulleys, the right V-Belts, the right sprockets and the right roller chains. So . . . whether you are designing a new drive, or improving an old drive, get the solid help Maurey can give you. It's the sure way to end up with the one drive that is right for the job to be done.

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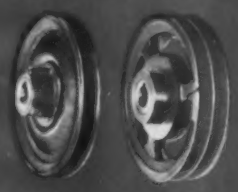

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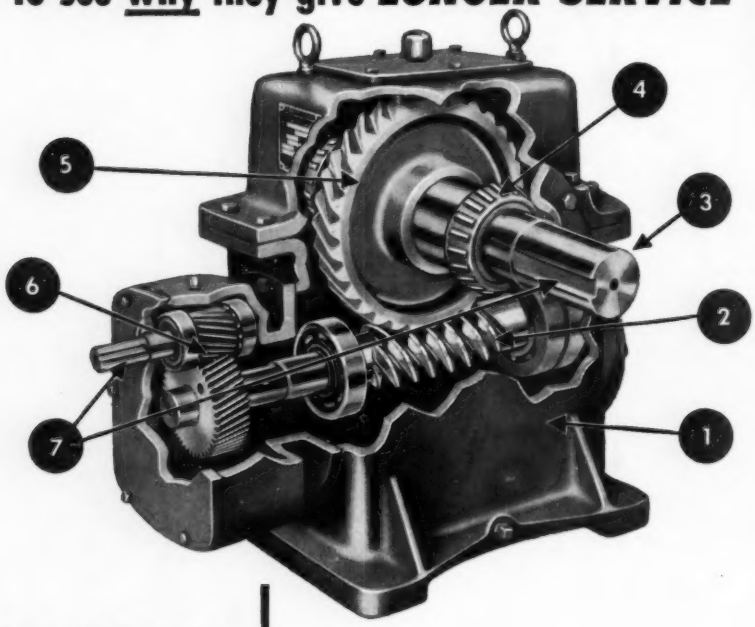
Look Inside a Foote Bros.

ENCLOSED WORM GEAR DRIVE

to see why they give LONGER SERVICE



1 EXTRA STRONG CAST HOUSING
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

2 PRECISION ALLOY STEEL WORM
Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 OVERSIZE OUTPUT SHAFT

4 HEAVY DUTY, EXTRA LARGE BEARINGS
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

5 WORM GEAR
Precision generated from uniform density, high hardness virgin bronze alloy casting. High load carrying capacity.

6 HEAT TREATED HELICAL GEARS
Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

7 Just one of 10 different types, in a wide range of sizes, ratios and shaft arrangements.

One look at the oversize bearings, larger shafts, precision made gearing and the sturdy housing of a Foote Bros. Hygrade Worm Gear Drive tells you that *this* is a workhorse unit that will stand up and deliver under the toughest conditions.

Notice the carefully balanced design . . . greater mass where it's needed . . . the elimination of weight when it contributes nothing to efficiency . . . strength and toughness at the right places . . . the correct gear alloys . . . the compact design, and above all, the simplicity and ruggedness of this unit.

When you know the *inside* story of Foote Bros. Hygrade Worm Gear Drives, you can understand why they have built a reputation for quality, dependability, and performance that is unmatched by others.

Write for Engineering Manual HGB. It contains complete information on Hygrade Enclosed Worm Gear Drives.

100 YEARS SERVING INDUSTRY 1859-1959

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
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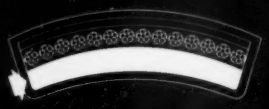
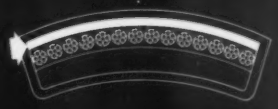
Want to control the ***V****ariables on your* ***V****ariable-speed drives?*

Control Slippage with Goodyear Variable-Speed Belts that have a specially compounded, abrasion-resistant cover to take a strong, uniform grip on both sides of the sheave.



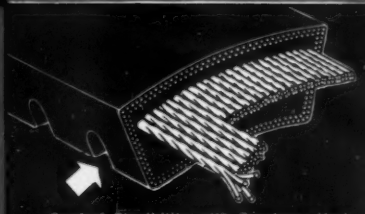
Control "Dishing" with Goodyear Variable-Speed Belts that incorporate a special, fiber-reinforced, synthetic-rubber compression section to resist side pressures – protect from fatigue.

Control Shrinkage-Stretching with Goodyear Variable-Speed Belts that are sinewed by exclusive Triple-Tempered (3-T) Cord for true dimensional stability in storage and in use.



Control Uneven Pull with Goodyear Variable-Speed Belts that feature a special, "cool-running" tension section to assure balance of yield – equalizing pull on either side of the belt.

Control Chasing Action with Goodyear Variable-Speed Belts that have a special "floating gum" insulating section to transfer all the load to the load-carrying cords.



Control Flexibility with Goodyear Variable-Speed Belts that are notched with absolute uniformity to bend easily over small pulleys without sacrifice of rigidity or strength.

Control Uniformity of Cross Section with Goodyear Variable-Speed Belts that are precision-molded for uniformity throughout their full length.

Variable-speed drives are tough enough—without having to contend with variations in the performance of the belts you use.

That's why so many design men insist on the *controlled* quality construction of Variable-Speed Belts by Goodyear. They know these belts are an invariable cure for the headaches so common to variable-speed-drive users.

For the belts that assure you maximum, trouble-free horsepower hours at minimum cost – in a complete range of 371 sizes to meet every need—check with the G.T.M.—Goodyear Technical Man—through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

IT'S SMART TO DO BUSINESS with your Goodyear Distributor. He can give you fast, dependable service on Hose, V-Belts, Flat Belts and many other industrial rubber and nonrubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."

VARIABLE-SPEED BELTS BY

GOODYEAR

THE GREATEST NAME IN RUBBER

For more information circle No. 13 on the Reader Service Card

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July 1959, *volume 1 number 7*

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FACTS

and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 48.

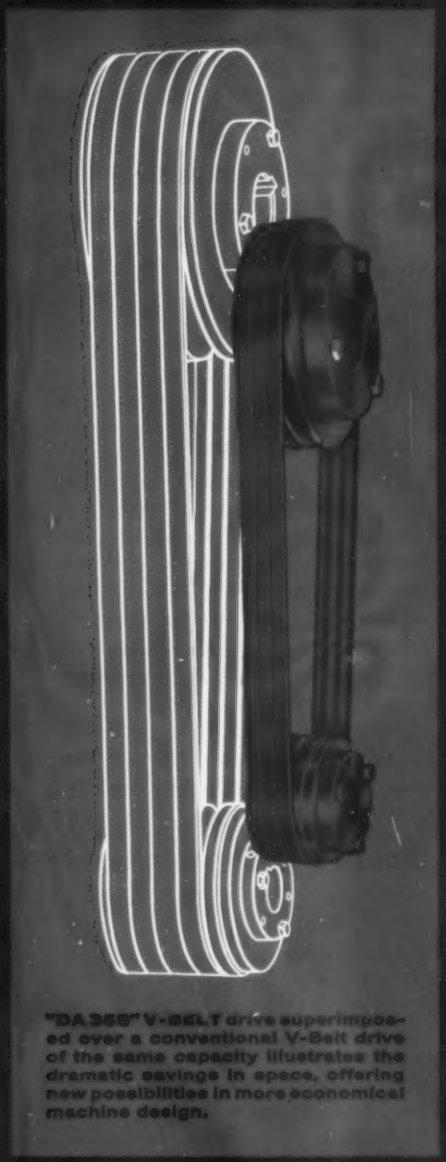
Now . . . from Durkee-Atwood

DA 358 V-BELTS

Introducing the entirely new V-Belt concept for compact, Plus-Power Drives

From Durkee-Atwood, pioneer manufacturer of high quality V-Belts for industry, comes the great new "DA 358" V-Belt, opening up completely new opportunities for highly compact, economical multiple V-Belt drives. "DA 358" V-Belts are engineered for unprecedented power transmission as compared with conventional V-Belts . . . with the ability to transmit more horsepower in a given area, at less cost, and with fewer belts, smaller, lighter sheaves and shorter center distances. They are manufactured with the quality and precision for which Durkee-Atwood is famous—quality which *we invite you to test.* Manufactured in 3V, 5V and 8V sizes.

SPECIAL: Durkee-Atwood's new "Red Shield" V-Belts now have a ***horsepower rating 40 per cent higher than former Standard V-Belts***— part of a major V-Belt upgrading program for improved drive design.



"DA 358" V-BELT drive superimposed over a conventional V-Belt drive of the same capacity illustrates the dramatic savings in space, offering new possibilities in more economical machine design.

We invite you to test DA 358 V-Belt against all other V-Belts

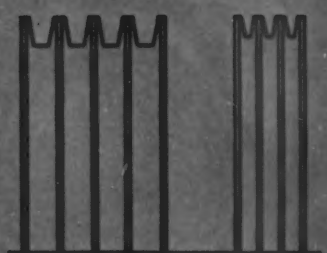
Write on your letterhead giving data, and we will forward to you our engineering recommendations.

Write

DURKEE-ATWOOD COMPANY

MINNEAPOLIS 13, MINNESOTA

Look for the DA *on your V-Belts*



SHEAVE WIDTHS are sharply reduced with a "DA 358" V-Belt drive. Figure at left shows sheave width for a conventional drive. Figure at right is sheave width for a comparable "DA 358" V-Belt drive.

For more information circle No. 8 on Reader Service Card

NEWS *from the power transmission field*

David Brown Ltd. affiliates with Foote

LONDON, ENGLAND—A substantial block of equity shares in Foote Bros. Gear & Machine Corporation is to be purchased within the next few months by the British firm David Brown, Ltd. The arrangement calls for David Brown to buy a 25 per cent interest initially, increasing its holdings in Foote Bros. to 50 per cent at a future date still unrevealed.

The affiliation involves two century-old firms in the power transmission equipment field. Full working co-operation will be achieved between the two companies with Mr. David Brown, chairman and managing director of the British concern, and Mr. Allan Avison, his co-director, becoming members of the board of directors of Foote Bros.

Founded in 1860, David Brown Ltd. is one of the principal engineering combines in Great Britain and is the largest manufacturer of gearing in Europe and the British Commonwealth. A wide diversity of products, including machine tools and accessories for the production and testing of gears, steel and bronze castings, farm machinery, and agriculture and industrial tractors, is made by the company, which also makes Aston Martin and Lagonda cars.

Commenting on the link recently, Mr. Brown said that he could foresee great benefits to both companies from the interchange of technical information. Cross-licensing of manufacturing rights for certain products in each of the two companies' lines is envisaged, and world-wide distribution under a combined David Brown-Foote Bros. name will be facilitated.

Van Norman gains control of American Pulley

NEW YORK, N. Y.—Van Norman Industries, Inc. has acquired working control of the American Pulley Company, in which it has held a minority interest for the last three years.

Charles F. Myers, Van Norman president and newly-elected president of American Pulley, has announced Van Norman's intention to use all its corporate resources to promote the profitable growth of American Pulley. He stated that American Pulley will be continued as a separate company and that no further changes in executive or other personnel are contemplated.

The Philadelphia concern has for many years manufactured power transmission and material handling equipment, and pressed metal specialties.

Van Norman Industries operate a number of companies, including H. W. Butterworth & Sons, Bethayres, Pa.; Morse Twist Drill & Machine, New Bedford, Mass.; Super Tool, Detroit; Van Norman Automotive Equipment and Van Norman Machine, Springfield, Mass.

Rocketdyne employs advanced gear inspection

LOS ANGELES, CALIF.—A new facility, the precision gear inspection laboratory, is capable of checking gear tooth tolerances to within one ten-thousandth of an inch. The new lab is part of the comprehensive rocket engine reliability program at Rocketdyne Division of North American Aviation, Inc.

According to Robert Heath, director of quality control at Rocketdyne, the inspection lab is one of the most advanced in the country. It features a 109-inch capacity spline and broach machine for checking and recording involute profile, spacing, lead angle, eccentricity and finish of splines and shafts before such parts are assembled into rocket engine turbopumps.

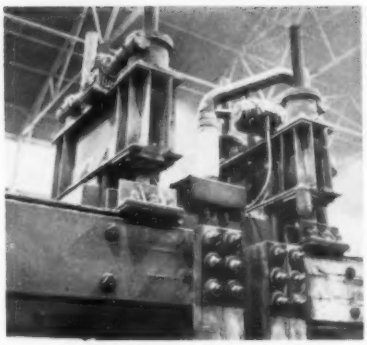
The lab's precision gear inspectors daily check hardness, finish, contour and dimensions of more than fifty gears. Among the inspection devices used is a comparator, picture of which is shown below, with a 30-inch screen capable of magnifying gear tooth profiles 62½ times—enough to make a human hair appear pencil-thick.

Special gearmotors for aluminum smelting

DETROIT, MICH.—One thousand compact, high-temperature, double-enveloping worm gearmotors are being used in the smelting of aluminum at Harvey Aluminum's plant at The Dalles, Oregon.

The smelting facilities at the plant contain rows of electric furnaces, or cells, housed in four separate buildings. The electrolytic cells in which the aluminum is made were designed, engineered and built by Harvey in its own Torrance, California works. Each cell, however, includes four of the gearmotors. Two units control the height of the anode in relation to the bath, and the other two control the position of the casing in relation to the anode.

The gearmotors have double-extended gearshafts and 40 to 1 reduction. Double-extended wormshafts with a 2½ inch center distance are used on half of the gearmotors. Rated capacity is 2 horsepower at 1750 rpm. The other 500 units have standard wormshafts, a 3 inch center distance, and are rated at 3 horsepower at 1750 rpm.



The ability to withstand ambient temperatures up to 300 degrees F was the most important consideration in Harvey's selection of the gearmotors, which are made by Cone-Drive Gears, in Detroit. Also important in the selection were the abilities of the gears to stand up under the full force of a stalled driving motor and frequent reversing operations.

CBBI nears release of design manual

EVANSTON, ILL.—Bearing designers and users will be able to design with confidence using the latest theoretical and experimental sleeve bearing design information available, members of the Cast Bronze Bearing Institute agreed, following their review of the latest draft of the CBBI technical manual. At a recent meeting in Chicago, member firm representatives studied and approved recent revisions and additions presented by Harry Rippel, project engineer, Franklin Institute, Philadelphia, who is serving as director of the manual's preparation.

New manual is said to simplify the designer's work by the substitution of graphs and equations for time-consuming trial-and-error methods. All areas of sleeve bearing application are covered. The manual will be available through CBBI members and the organization's office.

The Certificate of Merit of American Metal Market magazine was recently awarded the CBBI for its contribution in preparing the manual, among other citations.

New oil for hot engines

NEW YORK—A new synthetic oil for jet engines will let them run at higher temperatures for higher efficiency and more power from the same engine. Present lubricants are good for maximum temperatures of 300 F. The new oil will stand 400 F for long periods. Air Research and Development Command and Celanese Corp. of America developed the new oil which is ester-type gas fluid with additives such as phenothiazine.

AMF organizes new product group

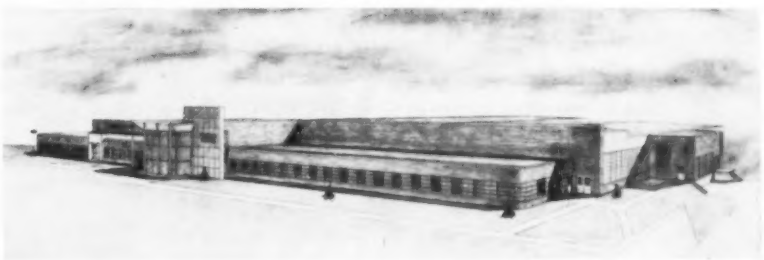
NEW YORK, N. Y.—American Machine & Foundry Co. has announced the formation of four of its branches into a new product group to strengthen the company's position in the electrical industry.

Members of the electrical products group are Potter & Brumfield, Inc., with plants in Princeton, Ind., Franklin, Ky., and Guelph, Ontario, manufacturing electrical relays; Leland Electric Motor Division, Dayton, Ohio; Leland Aircraft Products Division, Vandalia, Ohio; and Leland Electric Canada Ltd., Guelph, Ontario. Leland Electric manufactures fractional and integral horsepower motors, Leland Aircraft rotary and static power supply equipment for aircraft and guided missiles.

AGMA announces new memberships

WASHINGTON, D. C.—New company members of the American Gear Manufacturers Associates are Harry Frohman, Inc., Miami, Florida (represented by Harry Frohman, president); Parkersburg Rig and Reel Co., Coffeyville, Kansas (Charles H. Evans, research and development engineer); and Sargent Engineering Corp., Huntington Park, California (E. J. Sargent, vice president and general manager). Recent technical member is Boeing Airplane Co., Ind. Products Div., Seattle, Wash.

Franklin Electric builds at Bluffton



BLUFFTON, IND.—Building program now under way and scheduled for completion in November, 1959, will add 40 per cent more space to Franklin Electric Company's installation at Bluffton, Ind. New building will be devoted largely to electric motor production and office facilities.

Installation of special-design, automated machinery will account for 25 per cent more unit production, with an increase from 800 to 900 employees, according to E. J. Schaefer, president. Franklin is expected to take advantage of its increased facilities by producing newer types of motors and by broadening its marketing scope.

Here's what you reported in the recent . . .

Nationwide survey on

Report on GEAR SURVEY

***TO FOSTER BETTER** communications between users of power transmission products and manufacturers, the following is a report from across the nation, from all types of industries, from men who use gears, V-belts and roller chain.*

***Those polled included** chief engineers, factory managers, product engineers, maintenance superintendents, plant engineers, master mechanics, design engineers and many others.*

***There were just as many from the** San Diego area as from Chicago, Fort Worth, Jacksonville, Boston and other geographical areas throughout the country.*

THE REPORT ON GEARS is compiled from figures covering approximately 11,400 separate installations with either open gearing (shielded or not) or enclosed gearing, such as in gear boxes.

The average life of open gears of all types is approximately 4-12 years. The average life of enclosed gears is approximately 10-15 years. You considered this good life especially when units under light loads in clean environments with no lubrication problems operate 15 to 30 years without problems.

In some cases you replaced gears with other power transmission components:

- Approximately 7% of you replaced gears with V-belts in the past year because of noise, vibration, cost and maintenance—usually immediately after problems with the gears.
- Approximately 6% of you replaced gears with roller chain in the past year because of better installation convenience, ease of maintenance and noise, in that order.
- Approximately 15½% of you switched from open to enclosed gears because of lubrication and maintenance problems.

In some cases, you replaced other power transmission products with gears:

- Approximately 5% of you switched from roller chain to gears to gain better control over your operation.
- Approximately 2% of you switched from belts to gears because of belt problems.

Reasons

- Approximately 61% said you had gear problems of one kind or another; the remaining 39% had no gear problems. Of those who had problems:
- Approximately 53% said your gear problems are related directly to lubrication.
- Approximately 52% say gear problems show up in the form of excessive wear which causes noise and mandatory replacement.

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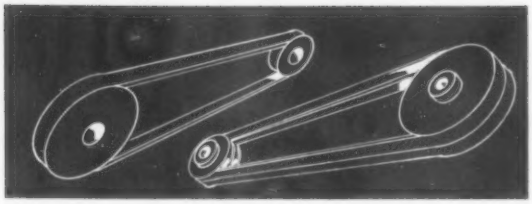


Gears, V-belts and Roller Chain

Report on V-BELT SURVEY

THE REPORT ON V-BELTS is compiled from figures covering approximately 16,400 V-belt installations.

The average life of V-belts is between 1 and 3 years with some belts operating 7 to 15 years. Most of you consider this good life and will replace belts with new belts when needed.

In some cases you replaced V-belts with other power transmission products:

- Approximately 6% of you replaced V-belts with roller chain during the past year because of slippage and overheating.
- Approximately 2% of you replaced V-belts with gear drives because of longer service life.
- Approximately 6% replaced V-belts with other types of belts because of stretch, slippage, speed and size limitations.

In some cases, you replaced other power transmission components with V-belts:

- Approximately 7% of you replaced gears with V-belts because of quieter operation and economy.
- Approximately 13% replaced roller chain with V-belts because of wear, dust, lubrication, noise and maintenance problems.
- Approximately 3% of you replaced other type of belts with V-belts because of better loading qualities and greater dependability.

Reasons

- Approximately 68% said you have V-belt problems of one kind or another. The remaining 32% had no belt problems of any kind. Of those who had problems:
- Approximately 38% thought that belt wear was objectionable and could somehow be reduced.
- Approximately 3% complained of V-belt noise.
- Approximately 70% felt that belt stretch was excessive and was the cause of other problems.
- Approximately 17% thought V-belts aren't as strong as they should be.

Continued on next page

Report on ROLLER CHAIN SURVEY

THE REPORT ON ROLLER CHAIN is compiled from figures covering approximately 9400 chain drive installations.

The average life of all installations is between 2 and 5 years with some units running as long as 15 years. Ability to keep lubricated is the major factor. Most of you consider chain life good and will replace with new chain when needed.

In some cases, you replaced chain with other types of power transmission devices.

- Approximately 5% of you replaced roller chain with gear drives in the past year.
- Approximately 13% of you replaced chain with V-belts in the past year because of rust, noise and lubrication problems.

In some cases, you converted other types of drives to roller chain operation:

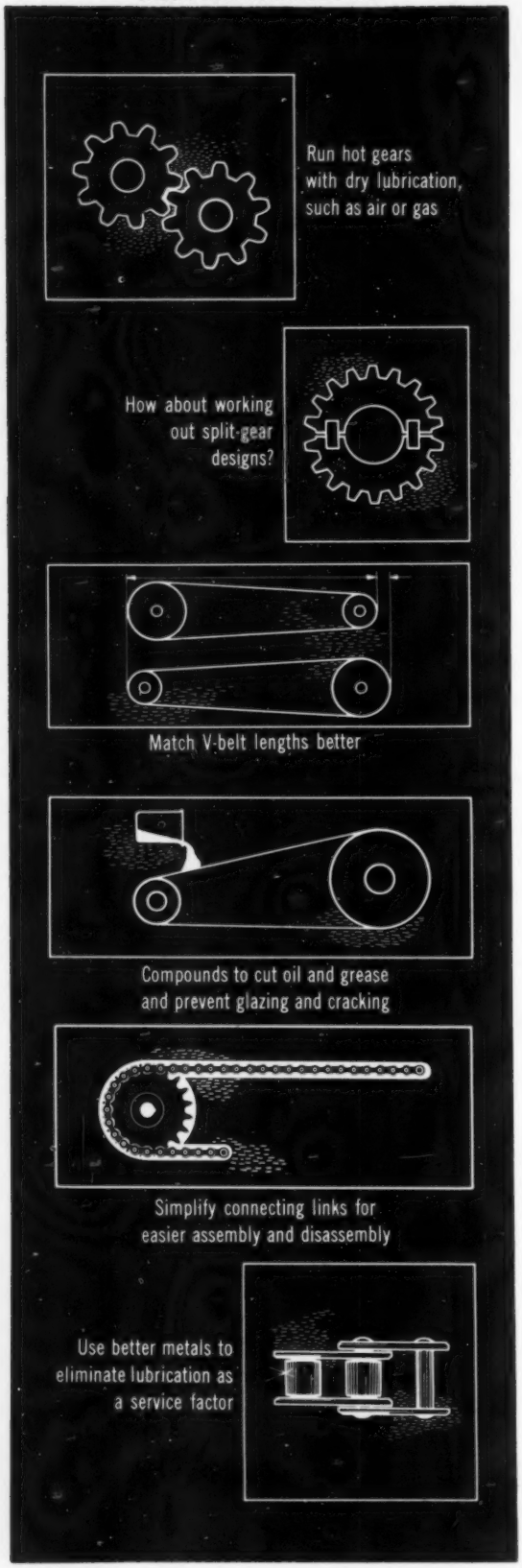
- Approximately 6% switched from gears to chain because of noise, installation and maintenance.
- Approximately 6% switched from V-belts to roller chain because of slippage, shock loading and speed control.

Reasons

- Approximately 64% of all polled said you had roller chain problems of one sort or another. The remaining expressed satisfaction with all chain installations. Of those who had problems:
- Approximately 77% related them to lubrication.
- Approximately 74% blamed short life and failure on wear.
- Approximately 24% objected because of noise.
- Approximately 32% considered stretch too much.
- Approximately 9% thought chain was not strong enough.
- Approximately 1% felt chain was difficult to specify to get the type desired.

Continued on next page

RECOMMENDATIONS


Run hot gears with dry lubrication, such as air or gas
How about working out split-gear designs?
Match V-belt lengths better
Compounds to cut oil and grease and prevent glazing and cracking
Simplify connecting links for easier assembly and disassembly
Use better metals to eliminate lubrication as a service factor

GEAR SURVEY *continued*

- Approximately 44% consider noise the worst operational objection.
- Approximately 8% are sometimes confused with manufacturer's data on specifying the gears you want.
- Approximately 9% don't feel you install gears satisfactorily after you buy them.
- Approximately 12% say you don't know how to service gears properly.
- Approximately 6% blame gear failures in gear boxes on seal failures.
- Approximately 8% blame gear failures on bad bearings.
- Approximately 6% say you have had gear box housings of interior quality with blow-holes or excessive porosity that caused failure.

Your Problems

Your gear problems are varied. Here are some of them in general order of their importance.

(1) Poor lubrication facilities for open gears.
(2) How to keep dust and dirt out of open gears.
(3) How to keep grease on open pinion gears.
(4) How to prevent excessive wear on all types of gears. Teeth not hard enough.
(5) High noise level.
(6) Inadequate seals that let oil or grease escape from gear boxes.
(7) Inadequate bearings that malfunction and let the gear trains get out of kilter.
(8) Having to shut down for long periods to replace gears.
(9) Cast iron gear teeth not hard enough.
(10) Cost of gears too high.
(11) Gears specified for continuous duty not hard enough.
(12) Open gears messy in food, textile and related industries.
(13) Poor dimensional and tooth surface quality.
(14) Loose fit on shafts in new machinery.
(15) Difficult to specify.
(16) Difficult to install.

Your Recommendations

Here are your recommendations that could help eliminate these problems. They are not listed in any particular order:

(1) Use tapered fits like those on sheaves and other shaft components.
(2) Work out split gear designs, like split bearings and sheaves to facilitate installation and removal.
(3) Issue simplified maintenance, specification and installation cards for men who don't take time to read manuals.
(4) Increase tooth hardness.
(5) Improve cast iron gears, especially surface hardness.

(6) Keep T.I.R. closer.
(7) Improve finish of semi-finish gears.
(8) Make all gears reversible.
(9) One major manufacturer runs a large operation at approximately 350F. Lubrication was major problem for years. Grease would break down; gears would fail. Chief engineer now running entire operation dry, without lubrication. No problems. Gears run well dry.
(10) Use higher quality seals and bearings.
(11) Eliminate need for oil or grease. Dry operation with air or gas might be the answer.
(12) Keep gears engulfed in oil to provide lifetime operation.

V-BELT SURVEY *continued*

• Approximately 8% of you had difficulty in specifying the type belts you want.
• Approximately 11% said you had major problems in installing and removing belts.

Some of you spoke of other problems which included poor matching, dry rot, corrosion, undesirable lubrication.

Your V-belt Problems

Your V-belt problems stick closely to a pattern. The problems are not great in number. The following are listed close order of importance.

(1) Poor matching of belt lengths.
(2) Deterioration due to chemicals, grease and oil.
(3) Belts cracking outside-in.
(4) One belt in a set stretching and overloading others so that all must be replaced to prevent uneven tightness.
(5) Belt glazing caused by dust inducing slippage and heating.
(6) Lack of standardization by manufacturers.
(7) Sheave wear.
(8) Belts make outboard bearings run hot because of the tight pull.
(9) Difficult to specify.
(10) Difficult to install and remove.
(11) Twisting when tightened.
(12) Poor instructions on use and care.

Your Recommendations

To eliminate these problems, here is what you recommend be done with V-belts, not listed in any order of importance:

(1) Standardize with same numbers by all manufacturers.
(2) Mark permanent identification on OD or PD.
(3) Match belts better for multiple installations.
(4) Make good quality belts to take apart like chain.
(5) Continue research on metal and fabric cords to continue fight against stretch. New V-belts being watched very closely. So far, all good comments; only one minor negative comment.
(6) Make belts better heat-resistant.
(7) Two types of compounds needed: to cut oils and greases; to keep older belts from dry-rotting and cracking. Quite a few claim belts would last 15 years if cracking could be prevented.
(8) Stop use of undersize bearings on shafts driven by belts.
(9) Make smaller size belts.
(10) Make stronger; improve wear resistance.
(11) Improve specification and installation instructions.

ROLLER CHAIN SURVEY *continued*

• Approximately 10% said chain was difficult to install and remove.
• Approximately 19% said chain was difficult to service and keep in operation.

Your Problems

Roller chain problems are few and categorized as follows:

(1) How to keep lubricated.
(2) How to shield to keep out dirt and dust.
(3) How to prevent messy condition when grease mixes with dirt and causes gummy paste.
(4) Stretch due to pin and roller wear.
(5) Mis-pitching due to stretch even though sprockets are not worn.
(6) Repair links not simple enough.
(7) Stretch due to shock loads.
(8) How to lubricate exposed chain.
(9) Sprocket wear.
(10) How to clean and keep clean.
(11) How to lubricate at high temperature.

Your Recommendations

Most of you had recommendations that might improve roller chain performance. Here are some of them:

(1) Eliminate lubrication as a factor by using higher quality metals that will not rust.
(2) Use internal, external or self-lubricating devices that not only lubricate but clean.
(3) Use harder pins and rollers to prevent wear.
(4) Provide bath device that is simple and can be adapted to all chain drives.
(5) Heat treat side plates so they don't break.
(6) Provide a universal tightener, air or spring, to prevent slapping, overtightening and to take-up wear.
(7) A brush or blowing device to keep off dirt and dust.
(8) Make connecting links simpler for easier connecting.
(9) Eliminate oil and grease as lubrication mediums. Use air or gas.
(10) Design a shield or guard that dips and cleans each revolution.
(11) Use taper locks for easier installation.

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EDITOR'S PAGE

David R. Cartwright
editor

YOUR VOTE OF CONFIDENCE . . .

. . . has been well expressed in the first six issues of POWER TRANSMISSION DESIGN. We on the staff are taking this formal opportunity to thank you. Here's the score to date:

You've sent in over 20,000 inquiries for more information on new products, product literature and paid advertisements.

You've written us nearly a thousand letters.

Our first 55 advertisers have grown to 96 and there are many more whose products you will see advertised in the near future.

'You' now number 35,000 readers from an initial 25,000 which is nearing the complete cross-section of key men who guide industry in the advanced methods of conveying shaft power.

We have reprinted over 30,000 extra pages of various articles for distribution to interested groups at your request.

Pass along readership is 3 to 1. That is, reader service cards and other records show almost 90,000 total men read POWER TRANSMISSION DESIGN.

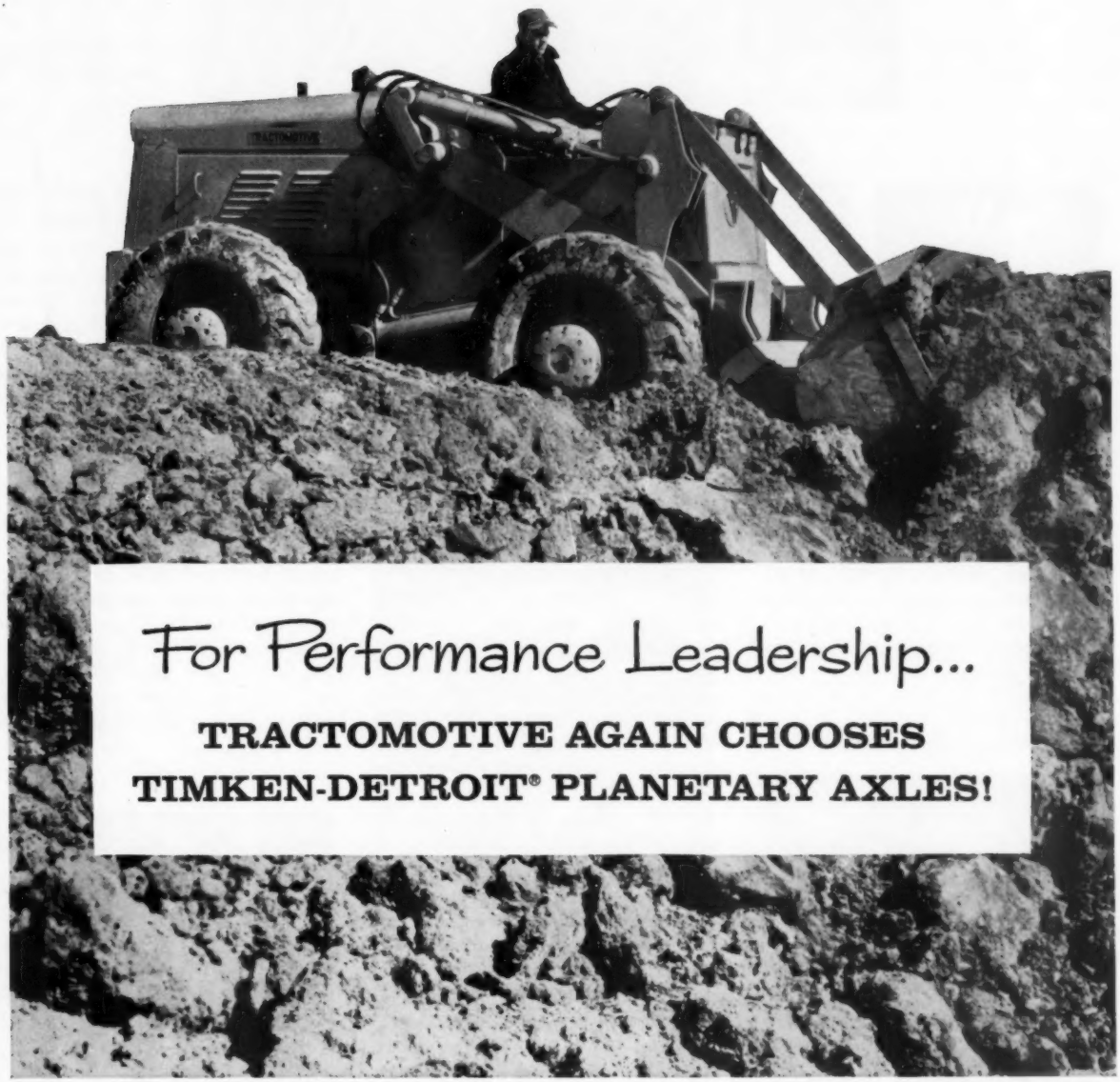
All of this is indeed gratifying.

WE CAN'T RUN A MAGAZINE . . .

. . . without this support. Thanks for it, and we promise our best for bigger and better things to come.

Dave Cartwright

Editor



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The new Tractoloader TL-14 has all the working advantages of the larger TL-20 and TL-16 Tractoloaders, including full power-shift transmission with exclusive one-lever speed and direction control . . . longer reach . . . greater stability. And to assure maximum payload and light weight, Tractomotive again consulted with Rockwell-Standard Axle engineers. They "customized" a standard planetary axle, and were able to meet Tractomotive's exact specifications. Result: The manufacturer avoided the high cost of a new, especially built component . . . production was started sooner . . . and the expense of additional facilities were eliminated.

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WHITTINGHAM

LYSETT

ROWE

Executive changes at Long Manufacturing

DETROIT, MICH.—In recent appointments at Long Manufacturing Div., Borg-Warner Corp., Harry H. Whittingham became president and general manager, and W. E. Rowe and Daniel W. Lysett were named vice presidents.

Mr. Whittingham is well known in the automotive and appliance fields, having served since 1957 as executive vice president and assistant general manager of Long Div. He has held production, sales, engineering and administrative positions with both the Norge and Detroit Gear & Machine organizations within the Borg-Warner Corp. Prior to his association with Borg-Warner, he was production manager for the Canadian products division of General Motors.

Mr. Rowe, new vice president, manufacturing, for Long was previously director of manufacturing for all Long plants in the Detroit area. He has served with various Borg-Warner divisions since 1927.

Mr. Lysett, named vice president, sales, for Long, joined the company in 1942 as chief clutch engineer, later becoming director of product engineering, sales manager, and director of sales.

Long makes radiators and other heat exchanger products, clutches and fluid torque converters, and drive line components for the automotive and farm implement industries.

BEATON

Twin Disc appoints Beaton

RACINE, WISC.—Donald E. Beaton is the new director of manufacturing for the Twin Disc Clutch Company's hydraulic division in Rockford, Illinois. Announcement was made by John H. Batten, company president.

Mr. Beaton has been assistant general manager of the hydraulic division since 1952. Prior to that time he was factory manager of the Thompson Products Company's accessories division.

Chicago district manager for Hewitt-Robins

STAMFORD, CONN.—Chelsea R. Phillips is the new Chicago district sales manager of the Robins Conveyor Division of Hewitt-Robins, Inc. Since 1951 Mr. Phillips has been Hewitt-Robins' sales manager in Hibbing, Minn., center of the Mesabi iron mining industry.

GE appoints Sutton marketing manager, promotes Naylor

SCHENECTADY, N. Y.—Clement E. Sutton was recently named manager of marketing in the General Electric Company's gas turbine department, replacing Edward G. Naylor. Mr. Naylor assumes a newly created position as manager of plant sub-contracting operations in the Schenectady public employee relations department.

Mr. Sutton has had academic and professional experience in electrical engineering and, since 1934, has served General Electric in both sales and technical capacities, most recently as manager of marketing in the apparatus service shops department. Mr. Naylor, who joined the company in 1940, has specialized in turbine sales in the Chicago district and in Schenectady.

MALLOY

Maurey appoints Malloy

CHICAGO, ILL.—Russell B. Malloy has been appointed vice president in charge of sales, according to an announcement from the board of directors of the Maurey Manufacturing Corporation, Chicago.

Mr. Malloy was promoted from his position as sales manager for all Maurey divisions which he had held for six years.

New District managers at Worthington

HARRISON, N. J.—Recent news from A. W. Fraser, general marketing manager, Worthington Corp., includes the appointment of two new managers of district sales offices.

Charles D. Wood has succeeded Richard M. Cleveland at the Boston district office. Mr. Cleveland retired June 30. With the corporation since 1939, Wood has been application engineer, field service engineer and technical representative, all at the Boston office.

New manager at Cincinnati, Ohio is Fred O. Snyder. Mr. Snyder succeeds Ralph G. Griffin who has been transferred to the company's home office in Harrison, N. J. Joining Worthington in 1941, Mr. Snyder has been sales representative and application engineer in the Cleveland area.

Other news from Worthington includes the appointment of B. R. McBath as general manager of the corporation's Plainfield division. His most recent assignment was as general manager of European operations.

SPEIDEL

Speidel heads SKF sales planning

PHILADELPHIA, PA.—Harold W. Speidel has been appointed manager of sales product planning with SKF Industries, Inc., it was announced recently by Stuart H. Smith, vice president in charge of sales.

The newly-created sales product planning organization, formerly the product department, will be part of the ball and roller bearing marketing operation. Speidel joined SKF in 1940, and was formerly district manager of Philadelphia-area sales.

WOOD

SNYDER

Hercules Motors appoints new manufacturing director

CANTON, OHIO—Adolph A. Karrasch, veteran truck engine production man for International Harvester Company, has been named director of manufacturing at Hercules Motors Corporation, William L. Pringle, president, has announced.

Clark names personnel chief

JACKSON, MICH.—Archie E. Sims has been appointed personnel director of Clark Equipment Company's Transmission Division. Announcement was made by George L. Turner, Clark vice president.

Mr. Sims had been staff mediator for the Michigan State Labor Mediation Board since 1946. Prior to that, he was associated with the John Miller Electric Company.

Cutler-Hammer appoints new quantity sales head

Warren G. Cudlip is new manager of quantity sales at Cutler Hammer Inc., Milwaukee. He was manager of the Grand Rapids, Mich., branch sales office.

Bradley promoted at Lincoln Engineering

Jack Bradley is a new assistant sales manager of the Industrial Div. of Lincoln Engineering Co., St. Louis.

Carver now asst gen mgr at Gleason Works

Howard F. Carver is newly named assistant general manager of Gleason Works, Rochester, N. Y. The post is a new one. Carver continues as vice-president in charge of sales and a member of the board of directors.

U.S. Industries picks Mandeville

M. L. Mandeville is now vice president and director of sales of the International Division of U. S. Industries, Inc. In his new capacity, Mandeville will direct export sales.

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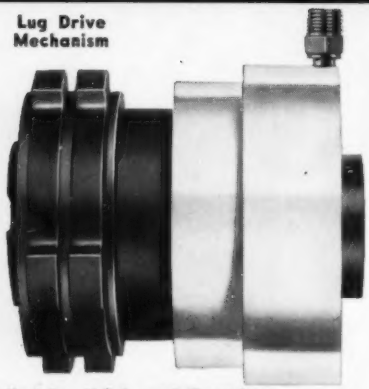
Gear Drive with Outflange Adapter

POWER *by Conway* THROUGH AIR

Lug Drive Mechanism



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"Just what we have been waiting for" is all we've been hearing. And as usual, Conway has come up with the right answer. Larger units designed specifically for your job. ALL with Conway's traditional conception of high quality at prices within reason.

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MODEL	DRIVE TYPE	NOMINAL WORKING TORQUE AT 60 PSI IN LBS.	DESIGN TORQUE AT 60 PSI IN LBS.
858-3	Lug	210	315
858-5	Lug	1260	1890
858-8	Gear	3780	6300
858-12	Gear	11340	18900
858-14	Gear	15120	22680

★ 6 drives available: Inflange or Outflange Adapter, Bronze bushed or Ball-bearing sleeve, Bronze or Ball-bearing pilot coupling. Additional models to be introduced soon.

Note: Torque can be increased on all models either by incorporation of sintered bronze drive discs or by increase of air pressure. Please consult the Conway engineers if this is desired.

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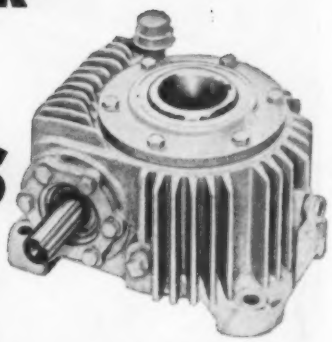
CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS



provide greater flexibility in the design of your equipment

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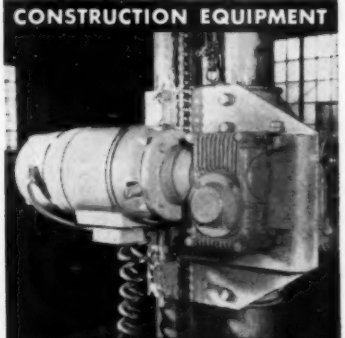


WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

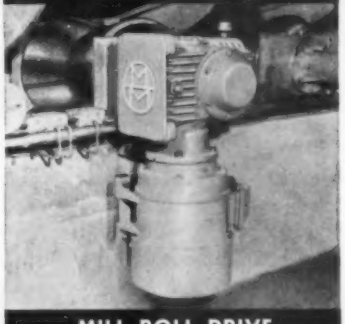
The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

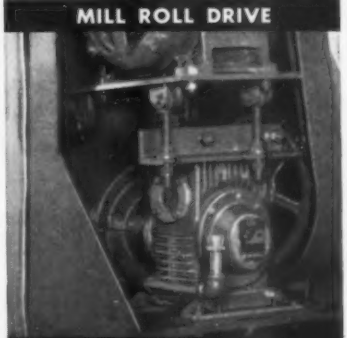
If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

Ask for Bulletin CD-218.

TROLLEY HOIST



MILL ROLL DRIVE



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HI-Line reducers are available in six new series ranging from 1.33" to 5.25" centerdistance. Standard models in each series include vertical with high or low base, and horizontal models with worm upper or lower.

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Manufacturers of gears and speed reducers - both stock and special

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LETTERS

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Reprints?

Gentlemen:

A recent AGMA Bulletin referred to an article "How to Cope with Critical Speeds" in the April 1959 issue of POWER TRANSMISSION DESIGN. We feel this article would be of interest to us, but have been unable to obtain a copy. Can you help us?

GEORGE PASCOE
Manager, Design and Standards Dept.
Manufacturing Engineering Office
Ford Motor Co.
Dearborn, Mich.

Gentlemen:

On page 29 of your April issue there is an article in connection with a book published by the American Society of Lubricating Engineers, Chicago, Illinois. If you could give us the street address of this organization, we would appreciate it, in order that we may write to them directly.

J. J. FINNEGAN
New York Trap Rock Corp.
West Nyack, N. Y.

Gentlemen:

I was pleased to receive the June issue of POWER TRANSMISSION DESIGN and to read the fine article you have written pertaining to our small motor. Would like to know if there is a chance to obtain reprints on this article.

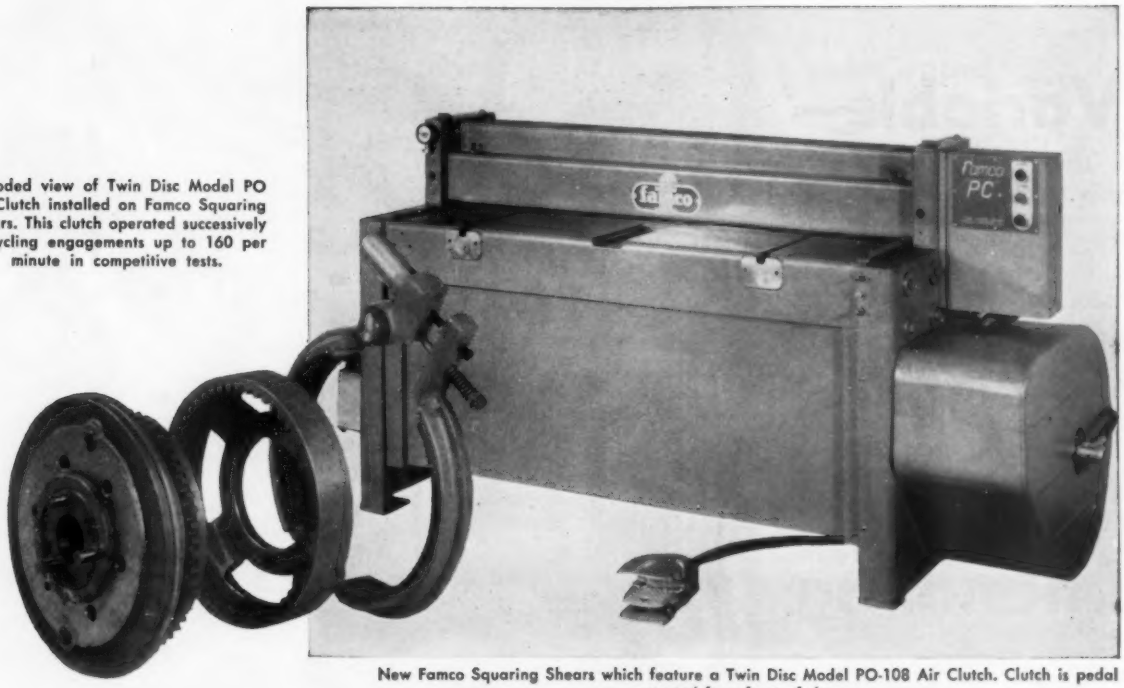
HEINZ A. MUELLER
President
Heinz A. Mueller Engineering Co., Inc.
Chicago, Illinois

Gentlemen:

We would appreciate receiving price on the following: 1000 and 3500 reprints of the Harry Pelphry article, your June issue; or, 50 copies of your June issue or 50 tearsheets of the article.

E. S. DENHAM
Denham & Co.
Michigan Tool Co.
Detroit, Mich.

Exploded view of Twin Disc Model PO Air Clutch installed on Famco Squaring Shears. This clutch operated successively at cycling engagements up to 160 per minute in competitive tests.



New Famco Squaring Shears which feature a Twin Disc Model PO-108 Air Clutch. Clutch is pedal actuated from front of shears.

Air clutch wins over electric clutch in fast cycling test!

When Famco Machine Company, Kenosha, Wisconsin, tested machine components for their new line of "PC" Series Square Shears they wanted a fast-acting dependable clutch.

Under controlled conditions, Famco engineers tested an electric single face dry clutch and a Twin Disc single plate 8" Model PO Air Clutch. The shear operates at 300 S. P. M., completing one cycle in 0.20 seconds. In cycling up to 160 single strokes per minute, only the Model PO Air Clutch could provide the fast action required.

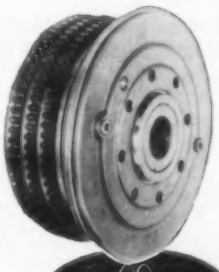
Today, the Twin Disc Model PO Air Clutch is standard equipment on Famco's new shears for 16, 18 and 20 gauge mild steel in widths of 36, 42, 52 and 72 inches.

Besides fast action, these new Twin Disc Air Clutches offer such other profitable advantages as:

- New design permits highest capacity at up to 40 per cent less cost than comparable remote controlled air clutches.
- Available in sizes 8, 10 and 11⅜ inches . . . in triple-plate, double-plate and single-plate construction . . . up to 3480 lb.-ft. in torque capacity.
- Exclusive cartridge-type diaphragm of long-lasting neoprene reinforced with nylon . . . eliminates leakage and provides long life.
- Constant torque capacity . . . no adjustment, self-compensating for wear.
- Compact and rugged . . . with clutch mass properly distributed relative to friction area, providing long life on high energy loads.
- Suitable for air systems up to 130 pounds per square inch.

These three new sizes extend the time-tested, job-proved line of PO Air Clutches from 8 to 36 inches . . . in torque capacities to 166,800 lb.-ft. . . . to meet the widest variety of industrial applications.

Test a Twin Disc Model PO Air Clutch in your laboratory . . . and include it in your next design. See for yourself how this type clutch lends itself to convenient, economical remote control. Write Twin Disc Clutch Company, Racine, Wisconsin, for complete details.



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

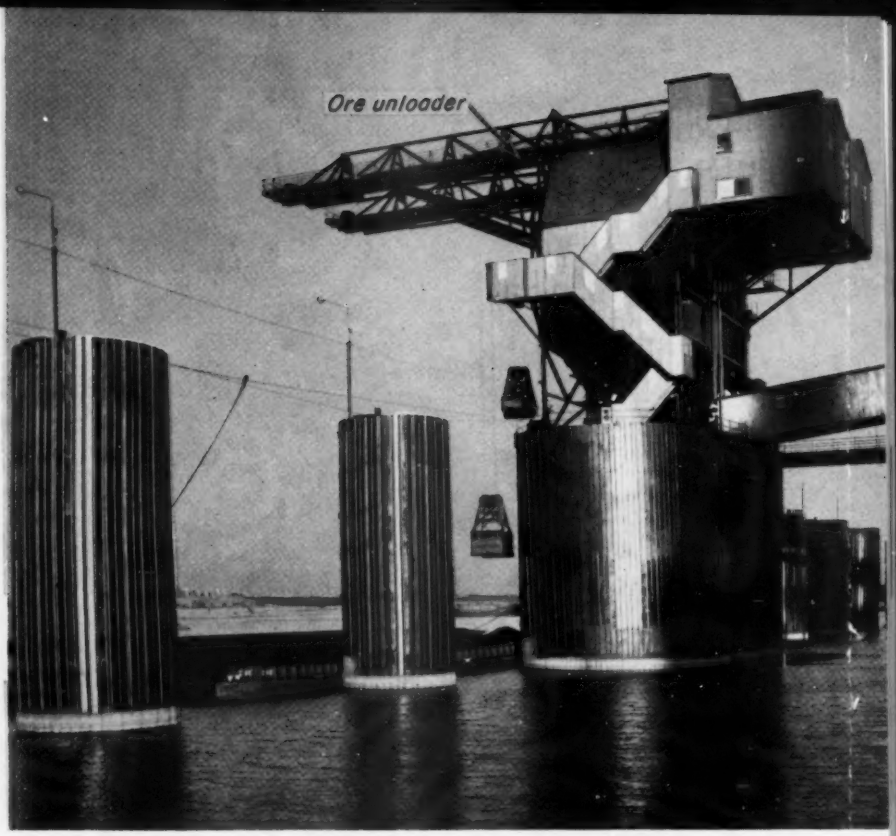
TWIN DISC
Clutches

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • LOS ANGELES • NEWARK • NEW ORLEANS

For more information circle No. 23 on Reader Service Card

Variable–speed drives speed material handling



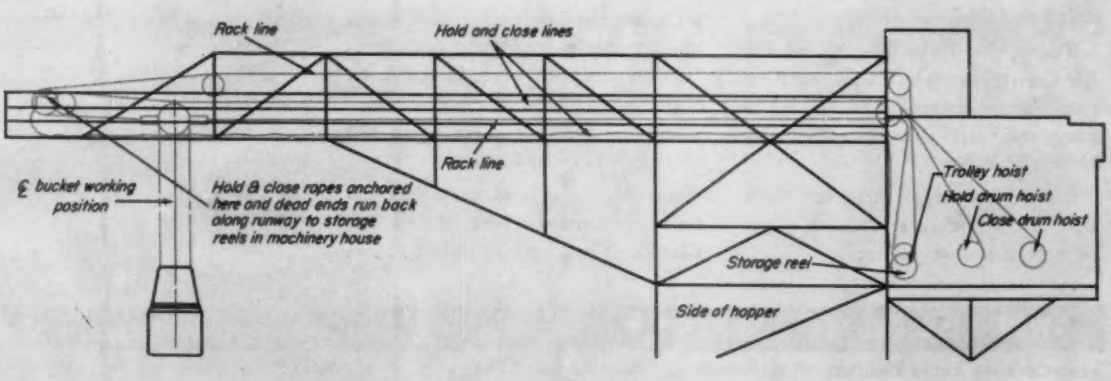
BULK MATERIAL HANDLING is made easy with variable speed drives on a new twin 13.3-ton coal unloader. Motor-generator sets located in the main control room power the cable winches letting the operator exercise his utmost skill for most effective speed of operation.

The unloader operates on 4160 v supply. The winches lower and raise the two buckets independently, advance and withdraw the trolleys, and move the coal barges into and out of position to better locate the coal supply under the buckets.

The hold and close lines have motor-generator sets that provide variable hoisting speed to a maximum of 600 fpm at 800 rpm motor speed. Lowering speed is variable to a maximum of 720 fpm with a roping ratio of 2:1. This is based on an average lifting distance of 90 ft. Empty buckets weigh 24,600 lbs each; loaded buckets weigh 51,200 lb. Speed is independent of whether buckets are full or empty.

The barge haul winches are not variable and are located in the base of the tower not in the main control room with the variable-speed equipment. They position the barges left or right for ease of unloading. The winches operate slow or fast at either 40 or 80 fpm, depending on whether the barge is loaded or at overhauling speed with no barge.

REEVING DIAGRAM shows connection of hold, close and trolley drums on new twin coal unloader built by Engineering Works Div., Dravo Corp., Pittsburgh, Pa.


Rock line
Hold and close lines
Rock line
℄ bucket working position
Hold & close ropes anchored here and dead ends run back along runway to storage reels in machinery house
Trolley hoist
Hold drum hoist
Close drum hoist
Storage reel
Side of hopper

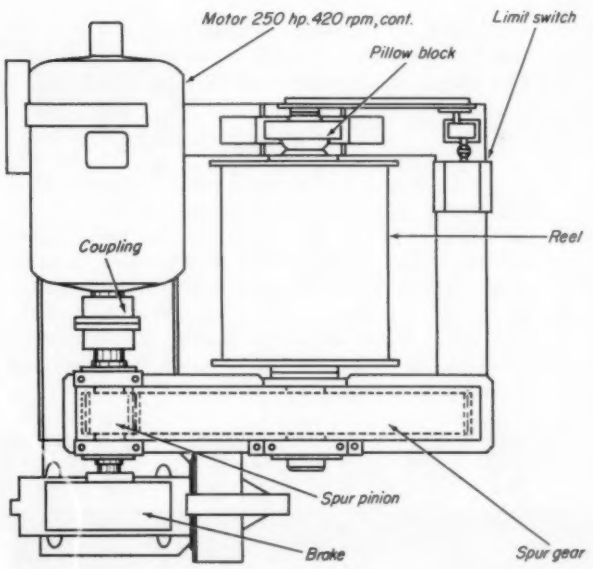
Feature 1: motor-generator sets provide variable cable speed

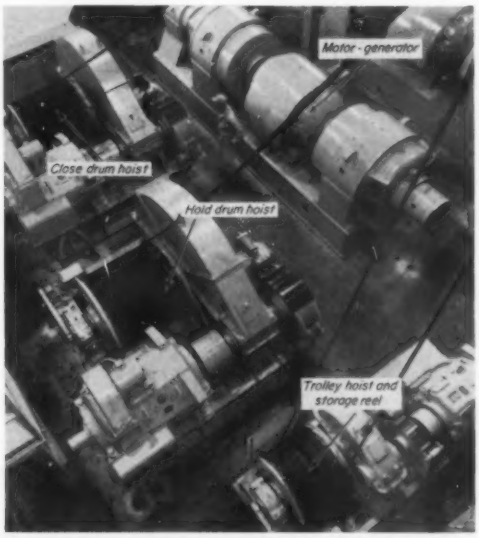
MOTOR-GENERATOR SETS power the *open, close,* and *trolley winch* motors. The motors are mill-type, dc, forced-ventilated with separately excited shunt-field windings. Speed of the motors is directly proportional to voltage applied to the armatures by the m-g sets. Direction of rotation is determined by voltage polarity.

Generator voltage is controlled by amplidyne exciters that provide dc torque control. During speed-up and retardation, torque is thus held to a constant value. These values, however, are considerably less than peaks experienced on earlier equipment using conventional rheostat controls.

The drive control circuits cause the load to be picked up free of jerks; motors are therefore not subject to shock loads. This provides longer life for all drive components and cables, cuts power consumption and lowers KVA peaks on the power supply.

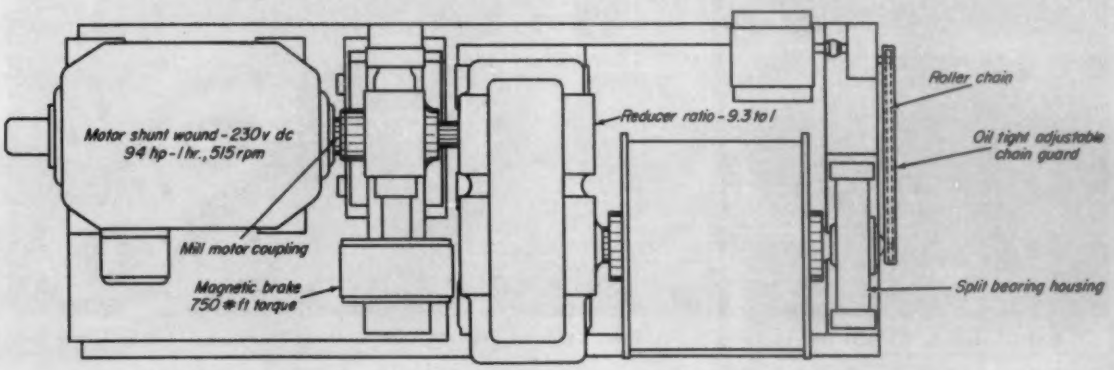
The amplidyne control divides the load approximately equally between the hold and close cables when hoisting or lowering a closed bucket. This is done with both master switches in full speed position. When lowering an open bucket, with both master switches in full speed lowering position, speed of both the hold and close motors is matched to keep the bucket jaws open and to keep excessive slack out of the close line. If desired, the bucket jaws may be either opened or closed while the bucket is in motion.



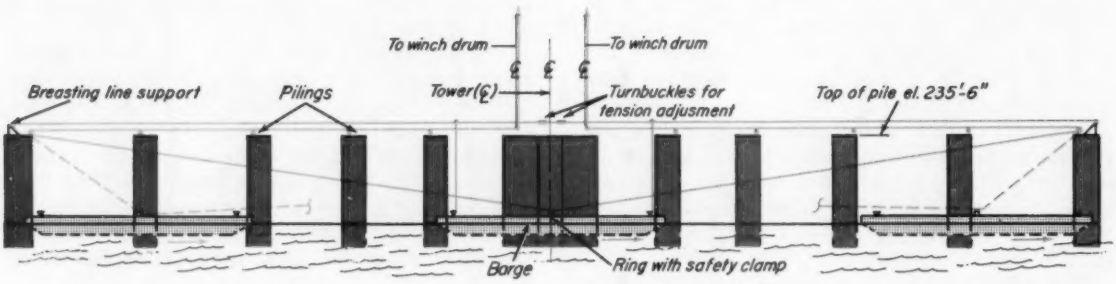


HOLD AND CLOSE drums have variable speed; go slow or fast according to operator selection.

No. 1. For more information on any component in this article, see page 49


Motor shunt wound - 230v dc
94 hp - 1 hr., 515 rpm
Mill motor coupling
Magnetic brake
750 # ft torque
Reducer ratio - 9.3 to 1
Roller chain
Oil tight adjustable chain guard
Split bearing housing

Feature 2: auxiliary drives adjust bulk material position



LOADED BARGE can be moved left or right in water to better position coal pile under buckets.

THERE ARE TWO barge haul winches, powered by 2-speed motors, that move the barges left or right in the water to position the bulk coal under the buckets. Each winch operates at 40 fpm or 80 fpm depending on whether the barge is loaded or unloaded.

Control for the winches is tandem or individual. When operated tandem, the hauling winch produces its required line pull while second winch produces a slight restraining force to keep the lines taut and provide better control of barge motion.

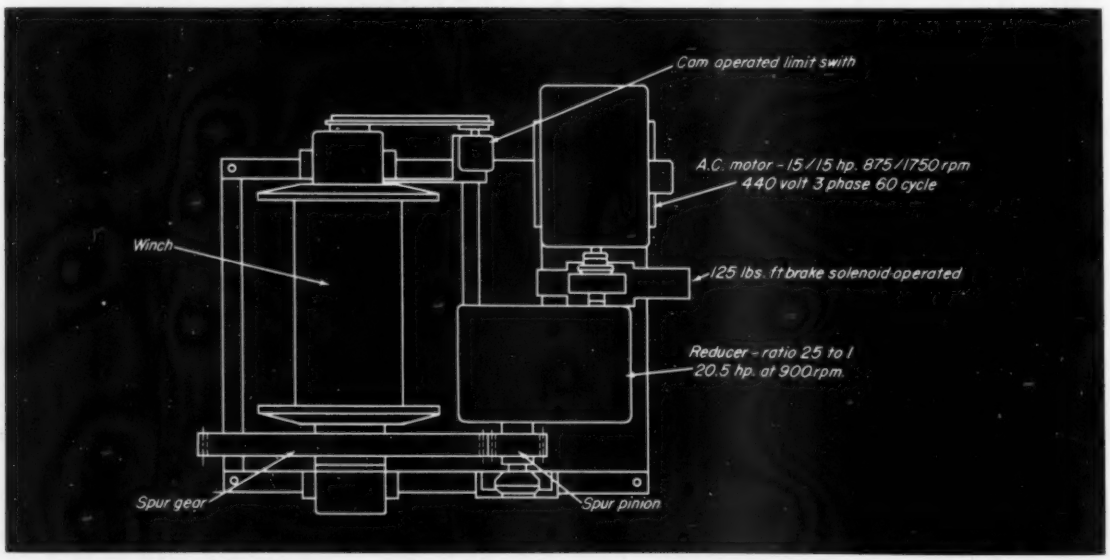
The winches are reeved to pick-up a barge 575 ft up or down stream and move it an equal distance in the opposite direction.

Total weight of the winch is 7400 lb plus weight of the cable. Maximum starting line pull is 31,000 lb which is 275% of rated line pull of 11,260 lb at 40 fpm. Cable size is $\frac{7}{8}$ in. dia and speed is 40/80 fpm. The cable drum is made of nickel-alloyed cast iron.

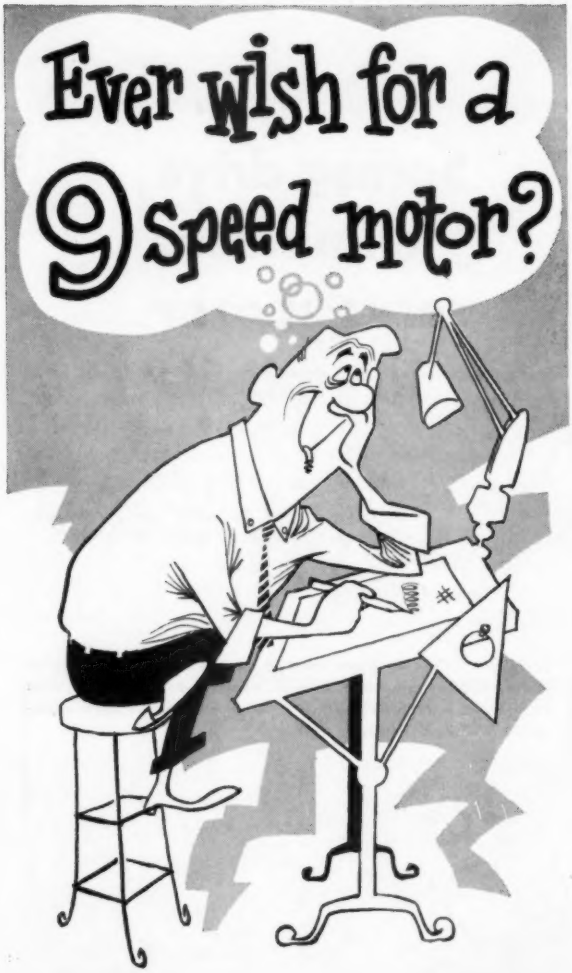
Brakes

Automatic stop protection is provided for all hoist and trolley operations—both mechanical and electrical. To intentionally stop the trolley, for instance, the operator reverses the master switch which reverses motor current. This stops the motor electrically and is known as plugging. In case of electrical failure, the mechanical brakes set automatically. If the operator overruns end limits, limit switches cut the power and the mechanical brakes set.

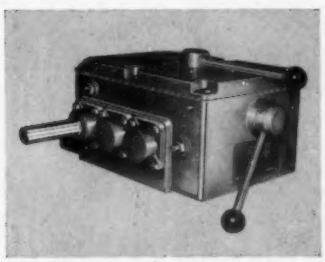
No. 1. For more information on any component in this article, see page 49


Cam operated limit swith
A.C. motor - 15/15 hp. 875/1750 rpm
440 volt 3 phase 60 cycle
Winch
125 lbs. ft brake solenoid operated
Reducer - ratio 25 to 1
20.5 hp. at 900 rpm.
Spur gear
Spur pinion

BARGE HAUL WINCH has two speeds: 40 fpm, barge loaded; 80 fpm, overhauling speed with no barge.



TRY TURNER



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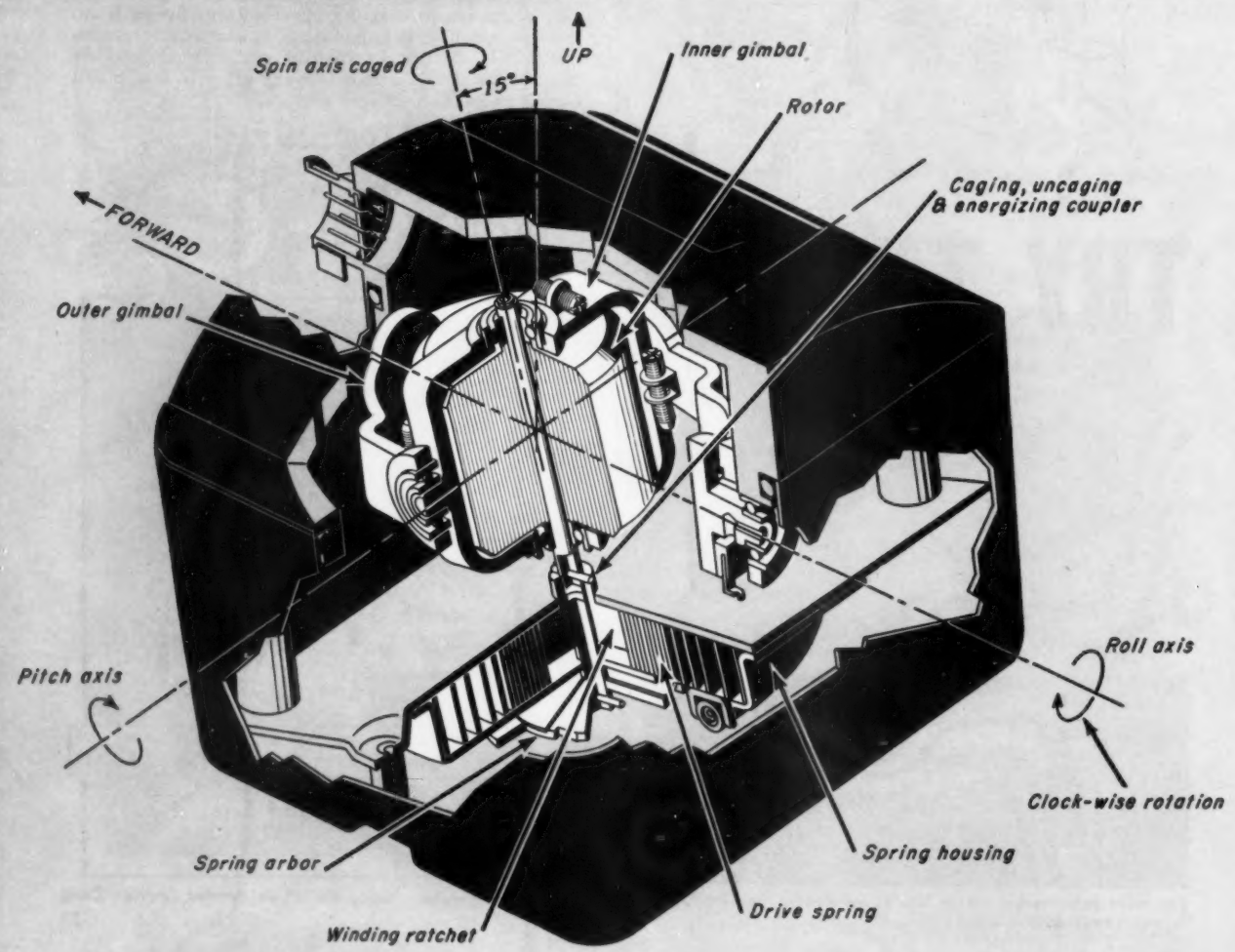
Spring drive eliminates servo motor in missile

By KENNETH W. BROWN, *project director, Whittaker Gyro Div., Telecomputing Corp.*

SPRING MOTOR gives energy for gyro on short-flight-time missile and saves weight and space. Gyros of this type have been designed for the Dart missile and high-speed target drones.



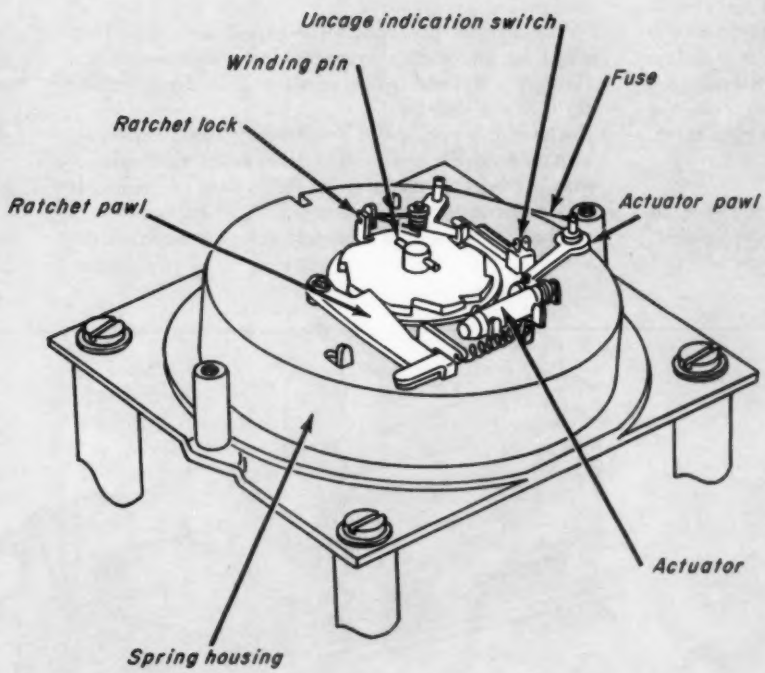
Precision miniature bearings eliminate most friction

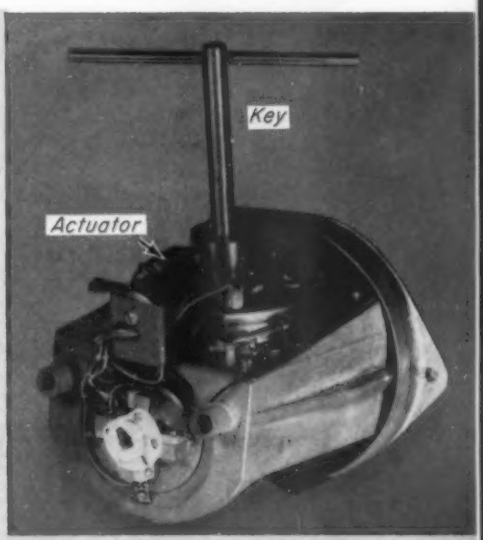
SPRING MOTOR and helical slot and pin coupling, like that used on the starting crank of a Model T Ford, reduce weight of a reference gyro in a guided missile. The gyro may be stored with the spring in wound position for long periods without loss of accuracy. Torque supplied in the model shown is 40 lb-in. for a period of 30 millisec. This is sufficient for a control action of at least one minute. Models have been made for control periods as long as 10 min.

The spring is wound by a key which fits a pin coupling much like the drive coupling. The spring arbor is held in position, until the gyro is energized by a ratchet and pawl. The pawl is pushed out of engagement with the ratchet by a spring-loaded plunger when an electrical fuse is burned through by an applied current. The fuse also releases a small spring-loaded arm whose purpose is to hold the drive coupling out of the way of the gymbaled portion of the gyro when it is up to speed.

When the spring has transferred all its energy to the gyro, the gyro tries to drive the spring arbor through the coupling. Instead, the pin, through the gyro rotor shaft, forces the helically-grooved portion of the coupling, spring arbor, and ratchet away from the gyro shaft. When this happens, the spring-loaded arm moves in between a circular plate on which the ratchet is mounted and the spring housing to hold the coupling in this retracted position so it can't interfere with free motion of the gyro. Motion of this arm also closes switch contacts to indicate that the gyro is ready to go. This whole series of events, from application of energizing current until the ready signal is given, take 0.1 sec. maximum.

No. 2. For more information on any component in this article, see page 49.





SPRING-DRIVEN GYRO in section and a detail of the energizing mechanism.

Rubber bands, string and springs for toys have evolved into Mylar belts. Nylon gearing and miniature motors for drives in life-size missiles and electronic equipment.

Flea-power is the

FLEA-POWER IS NOT NEW. It's a term applied to small size drives for toys and other miniature equipment regardless of its complexity.

However, very highly-skilled mechanical and electrical engineers design these units and have advanced the field into the high-precision industry that it is today. Many of the concepts of flea-power are being adapted into control devices by the military in full size missiles, helicopters and various types of electronic equipment.

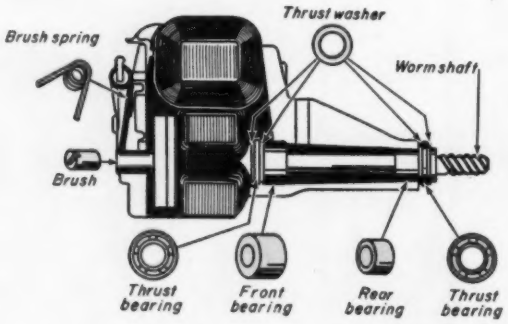
Low Cost

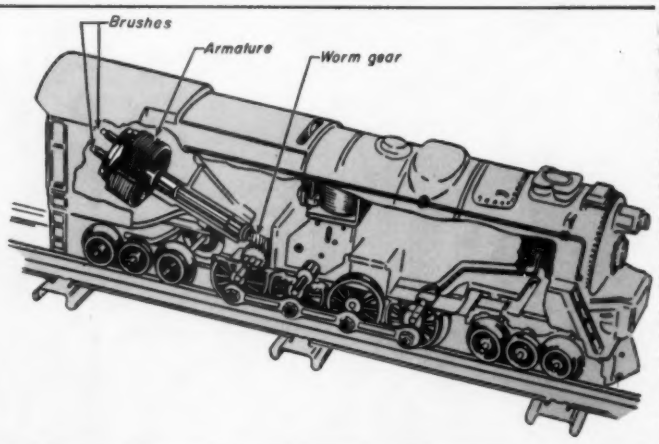
These products are miniaturized in appearance to resemble life size equipment. Any piece of equipment, complex as it appears, costs only a few dollars. Low cost is attained, not at the expense of lack of precision, but with high production concepts coupled with design.

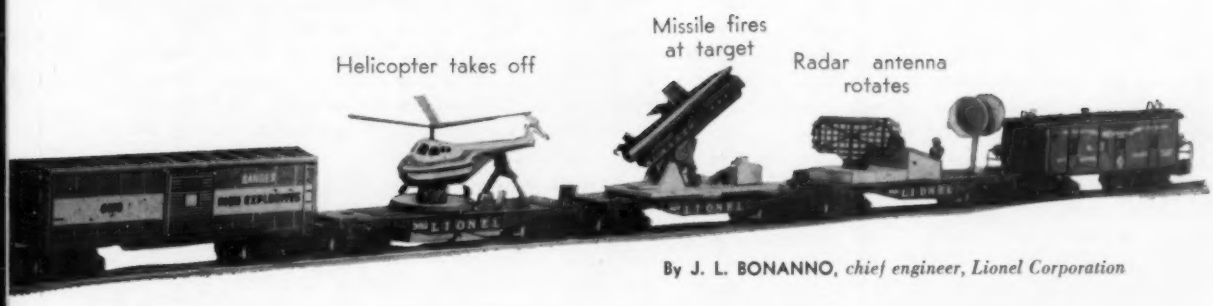
The motors used are series-wound a-c—d-c. They pick up low voltage current from the center rail through a collector roller or shoe. They are grounded through the outer rails.

The motor consists of a stationary field; three-pole armature which spins inside the field; and copper-graphite brushes that ride on the surface of the armature commutator.

They consume approximately 1 to 1.5 amp and de-







By J. L. BONANNO, *chief engineer, Lionel Corporation*

forerunner of miniaturization

velop 4000 rpm, at 10 to 14 volts under normal train load. Power is transmitted to the driving wheels in most of the units either through a worm and worm wheel or spur gears.

To attain scale speed of approximately 100 mph, a reduction ratio of approximately 8 to 1 is used. For larger wheel models, the ratio may be 18 to 1.

Worm Gearmotor

Worm gearmotors drive the wheels through a worm that meshes with a worm gear on the driving axle. The armature shaft runs in a lubricant-filled reservoir so as not to require frequent 'maintenance.' In cases where one end of the armature shaft runs in a bushing, an oil-soaked wick provides lasting lubrication.

Spur-Gear Motor

The field of the spur-gear motors has two sections. One is pivoted to permit motion when attracted by the magnetic field of the stationary field windings. As the movable field pivots downward, it moves a pawl that engages geared drums on the brush holder causing rotation. This reverses the electrical connections of the armature windings with respect to the field windings which reverses direction of motion.

The movable field and the pawl stay in the low position and lock the drums as long as the field windings remain energized. When current is interrupted, the pawl and movable field are returned to their unstressed position by force of the pawl spring so that the pawl becomes disengaged from the drum gears to be ready for the next indexing.

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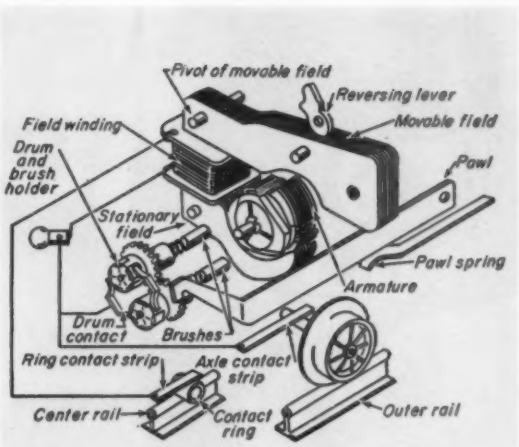
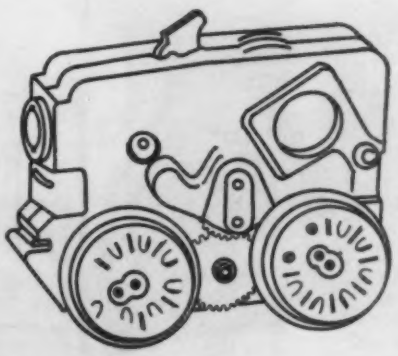




Vibrator motor rotates three shafts at different speeds

SMALL VIBRATOR MOTOR rotates three miniature figures at different speeds in an animated newsstand. It does this by pulsing a Nylon drive line that rotates a pulley and two plates with toothed racks.

The motor is connected to 60 cps a-c. The armature vibrates 120 times a second. Linear motion of the armature is translated into uni-directional rotary motion by the drive line acting on the pulley.

The drive line loops around the pulley and is connected to a small tension spring on the frame. As the coil energizes, the armature snubs the line on the pulley rotating it a fraction of a turn. As the field relaxes, the armature springs back and the drive line slackens but slack is taken up by a small return spring. Since the spring is relatively weak, the line slips back around the pulley without turning it. One-way clutching is thus effected. Each pulsation of current rotates the pulley through a small angle.

Mylar drive belt positions indicator dial from a-c signals

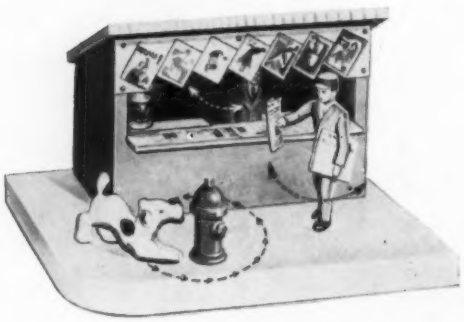
MYLAR DRIVE BELT INDEXES the dial on a miniature dispatch board. The board consists of a tiny vibrator motor, Mylar belt, Nylon drive line, carriage and pulley assembly and worm and wormgear unit.

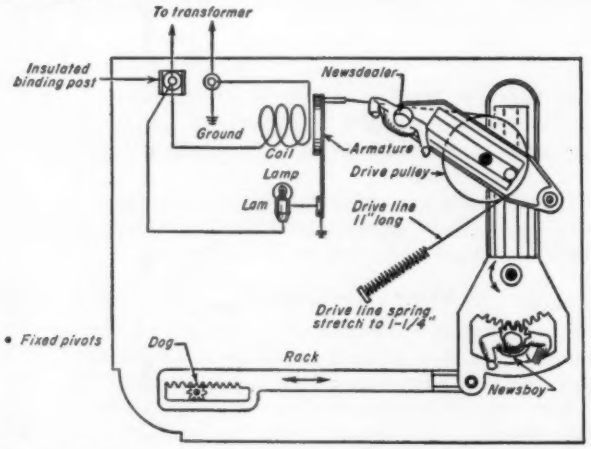
The motor drives the belt which carries an actuating finger. This finger turns a detented dial and also pushes a sliding carriage. Mounted on the carriage is a figure attached to a pinion which engages a circular rack also mounted within the carriage. At each end of the travel, the rack strikes abutments causing the figure to rotate 180 degrees.

To start, an electrical signal pulses the motor and advances the belt in short increments. The belt advances the carriage to one side of the unit to close a controller button. Action continues until the carriage completes a full cycle returning to starting position and opens an internal switch. This ends the cycle.

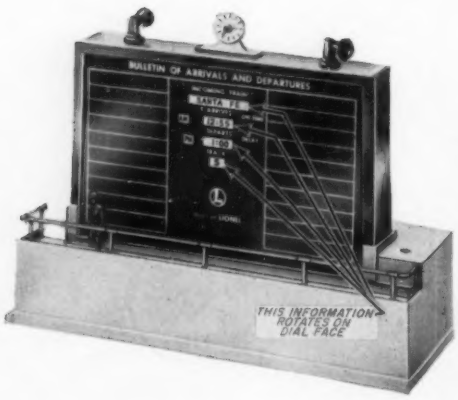
Operating range is between 10 and 14 v.

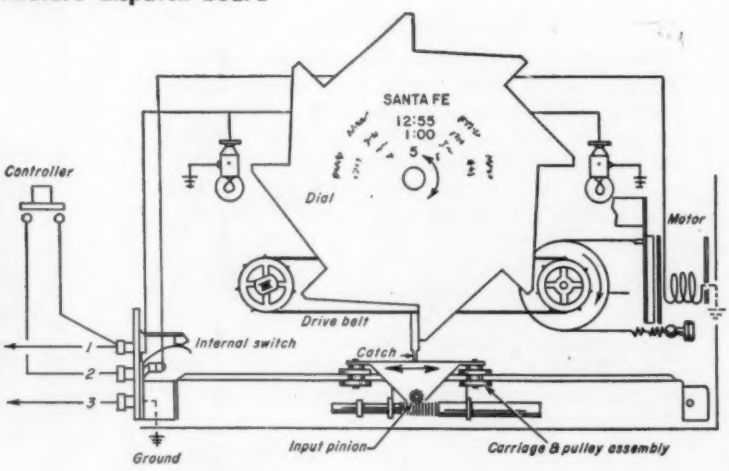
Miniature newsstand





Miniature dispatch board





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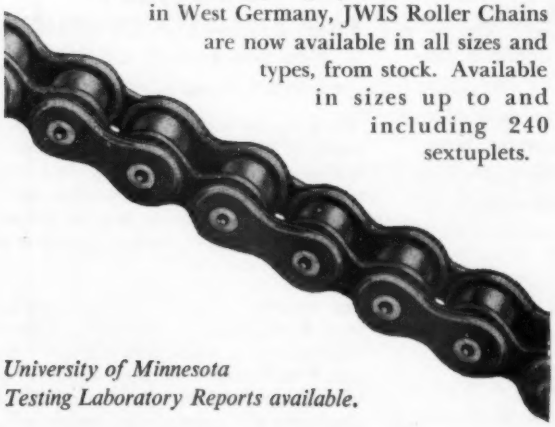

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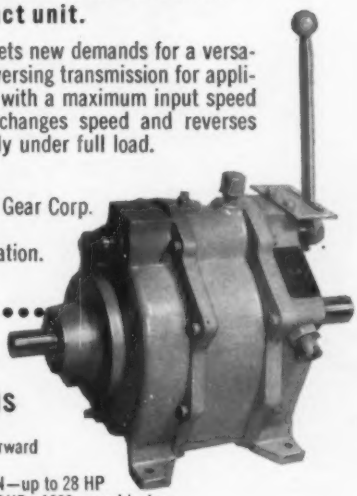

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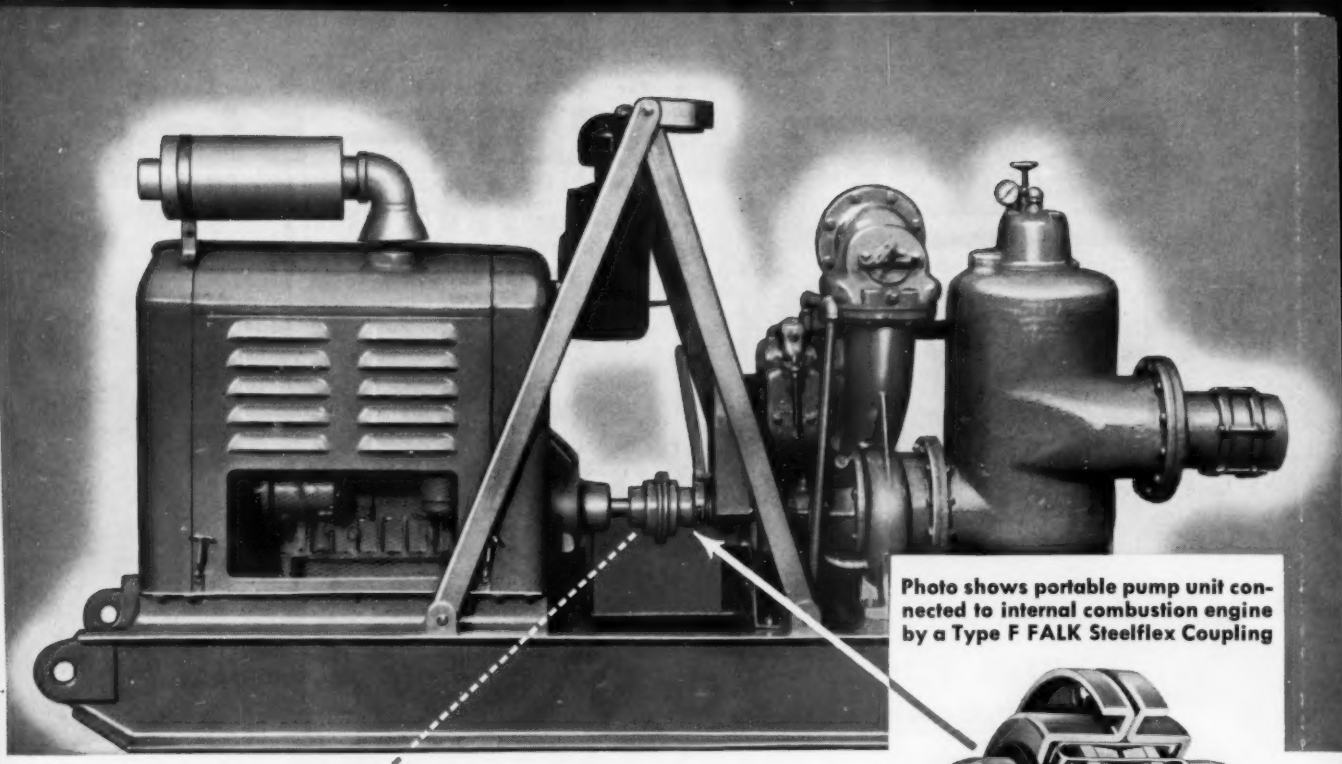

Photo shows portable pump unit connected to internal combustion engine by a Type F FALK Steelflex Coupling

How FALK STEELFLEX Couplings give your connected machinery Double Protection

FIRST: *They protect against shaft misalignment.* Some degree of shaft misalignment is unavoidable—and unless protective compensation is provided, additional loads are developed on shafts, bearings and other revolving elements. The result is excessive wear-and-tear—and often actual breakage....FALK Steelflex Couplings compensate for either angular or parallel misalignment—*or for the more serious condition involving both!* The exclusive Steelflex gridmember which joins the two hubs is not fastened to either hub; thus, either hub can shift in any direction without imposing a load on the other hub.

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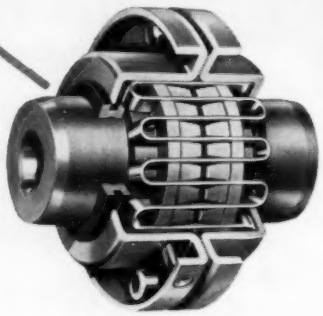


Basic Type F FALK STEELFLEX COUPLING fills the needs of 90% of industrial applications

This cutaway view shows the exclusive Steelflex design which provides *torsional resilience with the strength of steel.* This torsional resilience spreads peak or shock loads over a relatively long increment of time, thus *greatly reducing stresses* in connected machinery.

The versatile Type F Steelflex can be used horizontally or vertically, without modification or special parts. It is ideally suited to 9 out of 10 applications. For unusual applications involving overload conditions, extended shafts, brakes, etc., standard designs of dual-purpose Steelflex couplings are available.

For most applications, you can give your machines the extra protection afforded by FALK Steelflex Couplings at no extra cost!

FALK

...a good name in industry

US RUBBER **PowerGrip** "TIMING" BELTS

Why are today's outboards streamlined,.. faster, dependable?

A good deal of the reason is U. S. PowerGrip "Timing"® Belts, invented and perfected by "U. S." Engineers, now in use on the majority of the new outboard motors. PowerGrip gives a positive, non-slip drive. It assures constant electrical output without chance of slip-up—generator performs perfectly always.

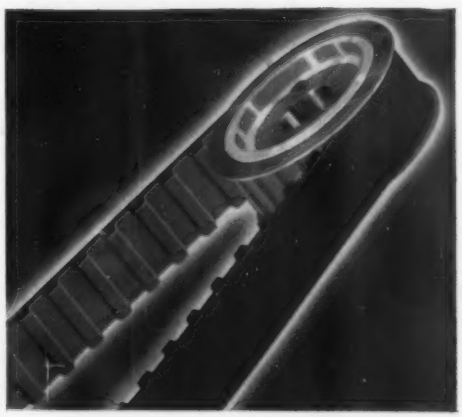
Other advantages that make PowerGrip indispensable:

- Trouble-free — no lubrication, noiseless, corrosion-resistant.
- Compact—short center-to-center distance, light weight.
- Safer—no slip to wear out belt, or cause breakdowns.

The U. S. PowerGrip "Timing" Belt drive may well improve your product, just as it has improved outboard motors. These drives are available in stock for every industry from U. S. PowerGrip "Timing" Belt Distributors, from fractional to 1000 hp.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



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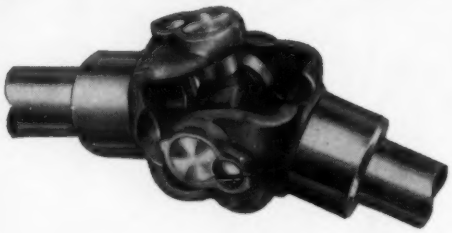
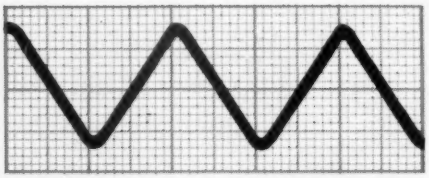
IN TORQUE TRANSMISSION

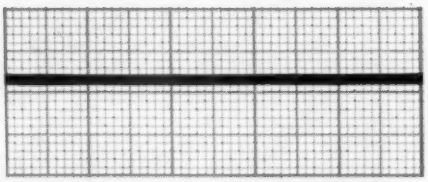


ORDINARY CARDAN UNIVERSAL JOINT



Mathematics and geometry prove this design joint continually changes shaft output velocity. During each revolution there are two high points, and two low points of speed and torque variation. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.

CONSTANT VELOCITY JOINT



This RZEPPA design joint *continually* transmits 100% smooth torque at all joint working angles. Such smooth torque action results from the drive balls applying force in a plane that bisects both input and output shaft axes.

Do you have a torque transmission problem that requires any one or a combination of these design improvements:

Less vibration	*Higher speeds*
Reduced bearing wear	*Greater angles*
Longer shaft life	*More capacity*

And, if your application warrants placing the solution and ultimate cost-savings above ordinary, lower priced joint designs . . . RZEPPA can help you.

RZEPPA Constant Velocity Joints are available for *light*, *medium* and *heavy* duty applications on air and space craft, vehicles and industrial machinery.

WRITE FOR LATEST LITERATURE or send your dimensional sketch along with peak horsepower, R.P.M. and operating angles. Without obligation, our engineers will assist you. Address: THE GEAR GRINDING MACHINE CO., Dept. TJ-759, 3901 Christopher Street, Detroit 11, Michigan.

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RZEPPA

CONSTANT VELOCITY UNIVERSAL JOINTS

Genuine RZEPPA Joints are made exclusively by THE GEAR GRINDING MACHINE CO.

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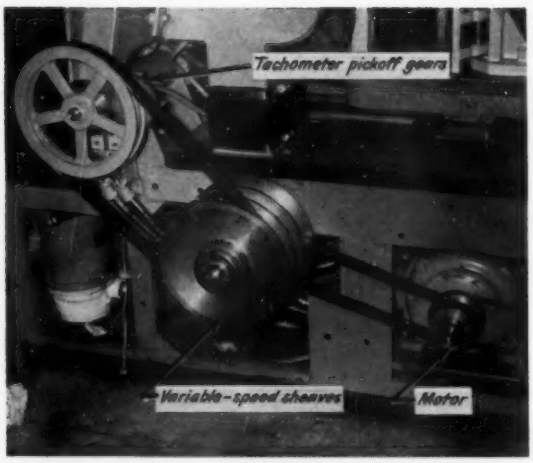
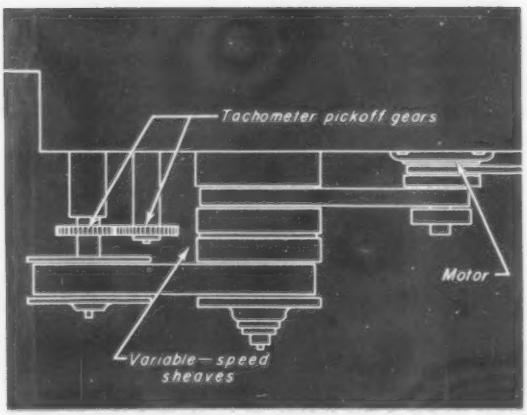
Two variable-speed sheaves on one shaft give high speed variation



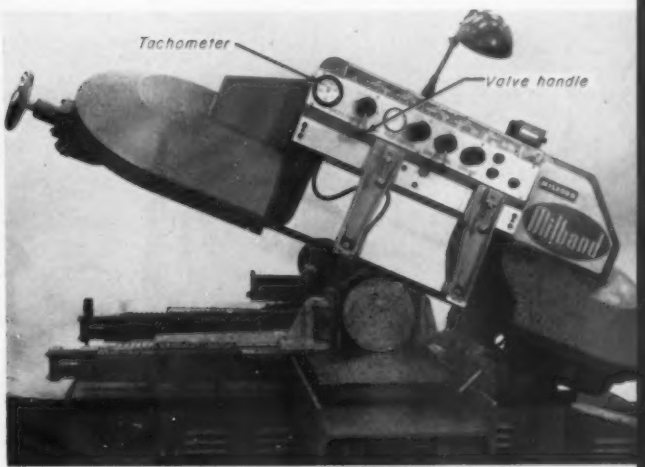
TWO VARIABLE-SPEED SHEAVES mounted on a single pivoted countershaft give speed variation of about 10:1 on a bandsaw. Ordinarily, speed variation obtainable with variable-speed sheaves is of the order of 4 or 5:1. Theoretically, of course, the same speed variation could be obtained with the sheaves mounted on a driving and driven shaft. However, one sheave would have to have three times the pitch diameter of those now used to give the same reduction ratio, if the input sheave were the same size.

Remote speed control is gotten by moving the pivoted shaft with a hydraulic cylinder. A hydraulic

Continued on next page



TWO VARIABLE-SPEED SHEAVES, mounted on a pivoted shaft give high ratio of speed variation.



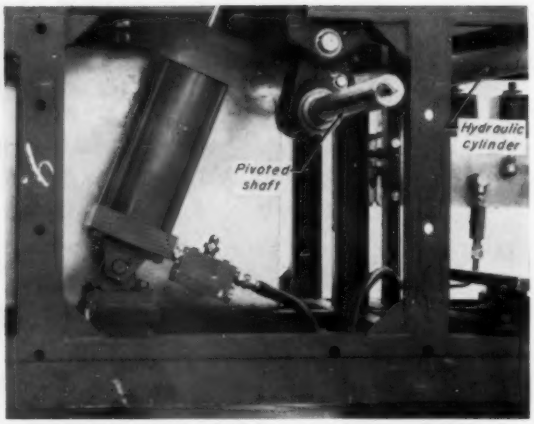
TACHOMETER AND HYDRAULIC VALVE for controlling the sheaves are on a panel on the bandsaw.

No. 3. For more information on any component in this article, see page 49

VARIABLE SHEAVES *continued*

control valve on the control panel lets the operator change speeds from the front of the machine. He simply moves the valve operating handle in an indicated *fast* or *slow* direction and when a tachometer on the panel shows the wanted speed he resets the handle to a lock position. The valve controls extension or retraction of the piston of the hydraulic cylinder and thereby causes the shaft to move and change the pitch diameters of the sheaves. A spring-loaded pivoted motor base compensates for sheave center distance changes.

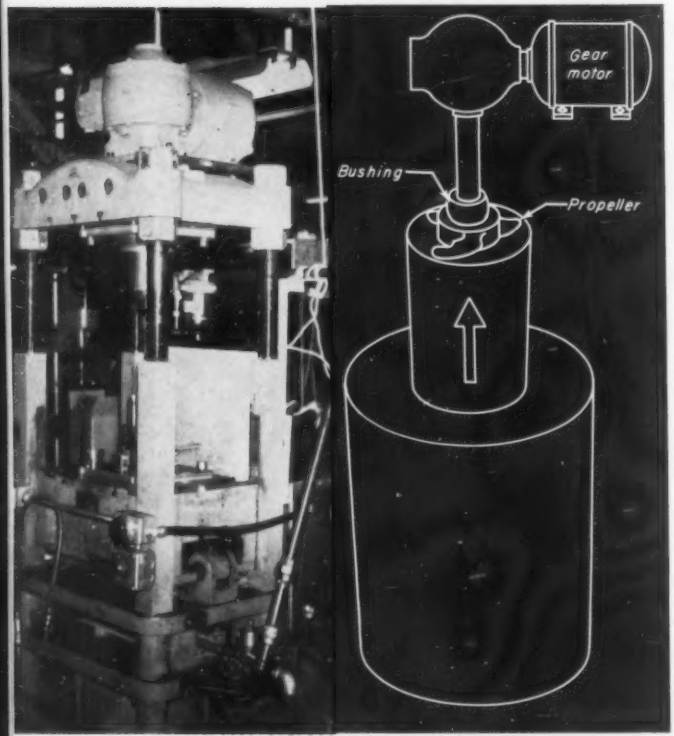
The bandsaw using this speed-changing system is made by *American Machine & Foundry Co.*, Brooklyn, N. Y., for Henry G. Thompson & Son Co., New Haven, Conn.



HYDRAULIC CYLINDER for remote control of variable-speed sheaves is visible here before sheaves are installed.

No. 3. For more information on any component in this article, see page 49

Gearmotor makes obsolete press new production machine



A GEARMOTOR mounted atop an unused hydraulic press has converted it into an extremely useful production machine. One of the assembly operations in the production of outboard motors is the insertion of the propellor bushing. This bushing is a metal sleeve with a rubber sleeve bonded to its outer surface. Its purpose is to isolate propellor vibration from the rest of the outboard motor unit. Since driving torque is transmitted to the propellor through the rubber sleeve, the bushing is fitted very tightly into the propellor bore.

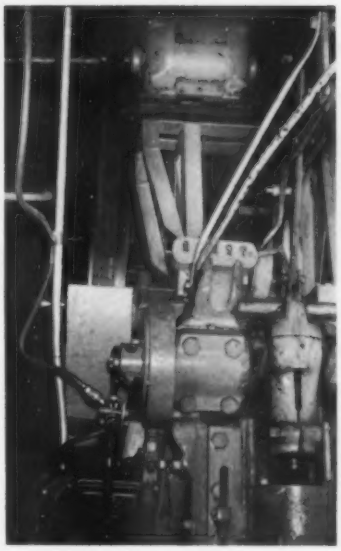
Before someone got the idea of converting the press, the bushings were inserted laboriously by hand at a rather slow pace. The process consisted of turning the bushing and at the same time pushing it into the propellor bore. By simply boring a hole in the upper platen of the press and mounting a right-angle gearmotor on it, a very successful machine was made to do the job. The gearmotor rotates the bushing at 300 rpm while the press ram forces it into the hub. Production rates have increased many times.

This conversion was made at the *Marine Products Div., McCulloch Corp.*, Minneapolis, Minn.

PROPELLOR BUSHING inserter, at left, was made from an unused hydraulic press by mounting a gearmotor on the upper platen. At right, principle of operation of the bushing inserter is demonstrated.

No. 4. For more information on any component in this article, see page 49

V-belts work successfully on flat pulley



TRIPLE V-BELTS drive directly from a sheave on a motor shaft to a large flat pulley very successfully on a punch press drive. Originally, the machine was driven by flat belting from overhead line shafting. In a modernization move, the machine was converted to an individual drive using flat belts driven by a countershaft atop the machine. The counter shaft was driven by V-belts and a motor mounted on the machine. This was then further simplified.

It was decided to try mounting the motor on top of the machine and driving the flat pulley with the V-belts. With a pivoting motor mount to adjust belt tension, it has proved to be completely successful. There are no problems with belts slipping off the flat pulley and the three belts have plenty of traction for the application. In fact, the users say they have less trouble with belt slippage than they did with flat belts.

Plant engineers at *Marine Products Div., McCulloch Corp.*, Minneapolis, Minn. thought this one up.

No. 5. For more information on any component in this article, see page 49

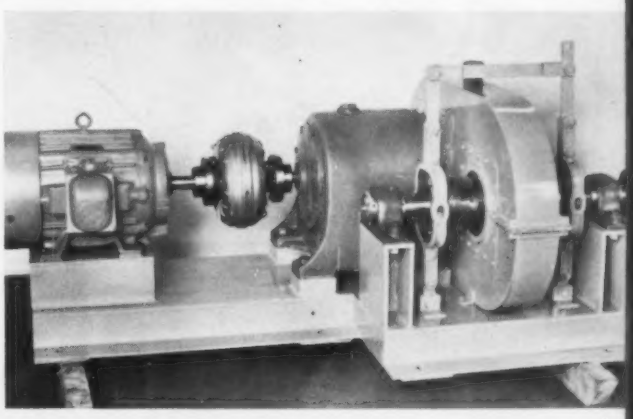
Fluid coupling, jaw clutches give compact two-speed drive

TWO CONSTANT-RUNNING CHAIN DRIVES deliver output speeds of 56.5 rpm and 381 rpm for powering a grain conveyor. Torque requirement at the lower speed is 3½ times that required at the higher speed. Horsepower is 20 at high speed, 10 at the lower. Output shaft of the drive unit is coupled to the appropriate chain drive by one or the other of two jaw clutches. Both clutches are operated by the same linkage. The enclosed chain drives take up very little space as the photo shows.

Between the two chain drives and the motor are a fluid coupling and an in-line speed reducer. The fluid coupling cushions shocks on starting and when the drive is reversed by reversing the motor. Overall efficiency of this system is 97%.

The conveyor carries grain from weighing bins to a marine tower for loading barges. It is reversed for unloading barges. High speed is used when bulk grain is being handled. The lower speed is for handling bagged grain. More time is required here for loading and unloading the bags. Chain and sprocket drive to the conveyor proper reduces conveyor speeds to 16 and 112 rpm.

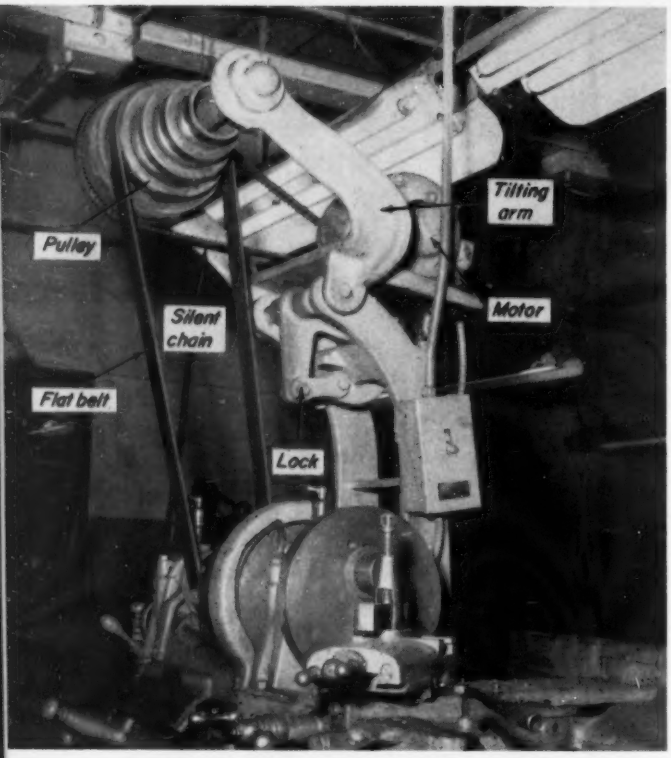
This transmission was designed and built by *Baldwin Supply Co.*, Minneapolis, Minn. for installation at a Russell-Miller Milling Co. dock in Alton, Ill.



DUAL-CHAIN DRIVE gives high and low speeds for a grain conveyor. Jaw clutches for selecting the right speed are operated by one linkage.

No. 6. For more information on any component in this article, see page 49

Silent chain solves slippage problem on machine tool



SILENT CHAIN and tilting platform in "drive" position.

SILENT CHAIN drive powers speed-adjustment pulleys on a lathe without slippage. This allows conversion of overhead-drive machines to individual drives and eliminates an overhead shaft in a machine shop.

Overhead shafting wore out bearings quickly and overhead lubrication drip-drained away. Belts stretched and slipped. Shaft downtime meant all machines stopped. With many machine tools designed for overhead drive, this firm was faced with two problems.

The first problem: How to give individual drives to overhead driven machines?

The solution: Development of a balanced tilting platform activated by a foot pedal which lowered the motor, its drive, and vari-diameter pulley-rack.

This releases the flat belt's tension, letting it fall slack. Stopping machine, the operator slips slack belt on needed speed-pulley, and releases foot pedal. The motor platform is spring-driven back into position, off-center linkage locks, holding the drive in place.

Second problem: Stopping belt slippage on the tilting drive transmitting power from motor to the vari-diameter pulleys.

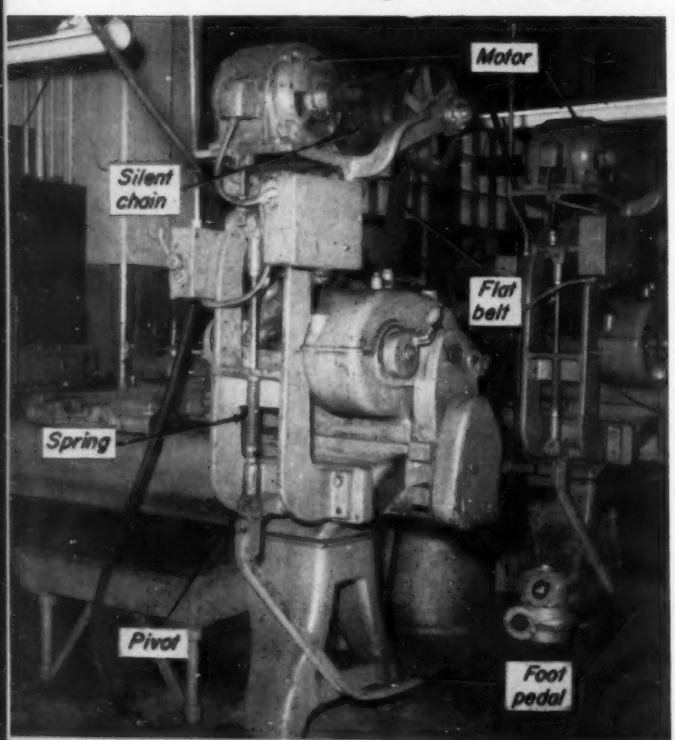
The solution: Use silent chain drive with center guide and toothed link-plates assembled on joint components.

Unit is powered by a 1-hp, 1725 rpm, motor driving a 2-inch pitch-diameter sprocket. Second sprocket has 10-inch pitch diameter.

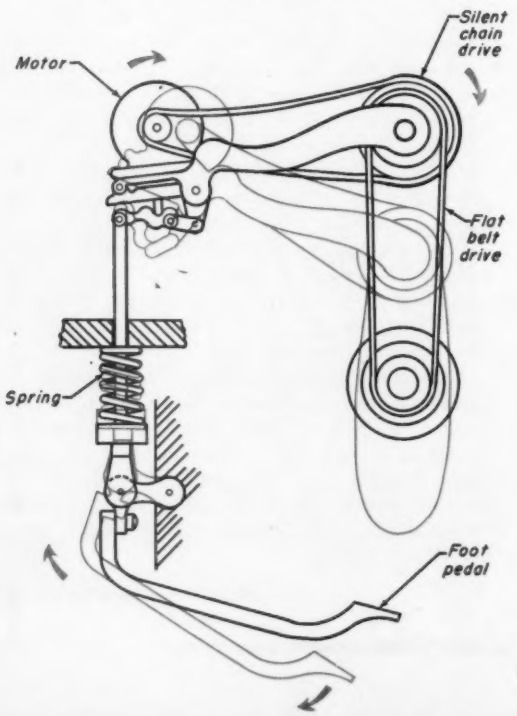
Chain application was developed and is now used at the *Ruthman Machinery Co.*, in Cincinnati, Ohio.

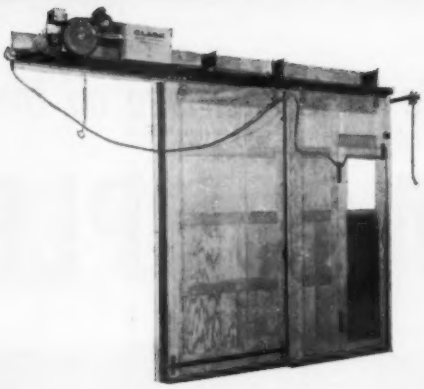
No. 7. For more information on any component in this article, see page 49

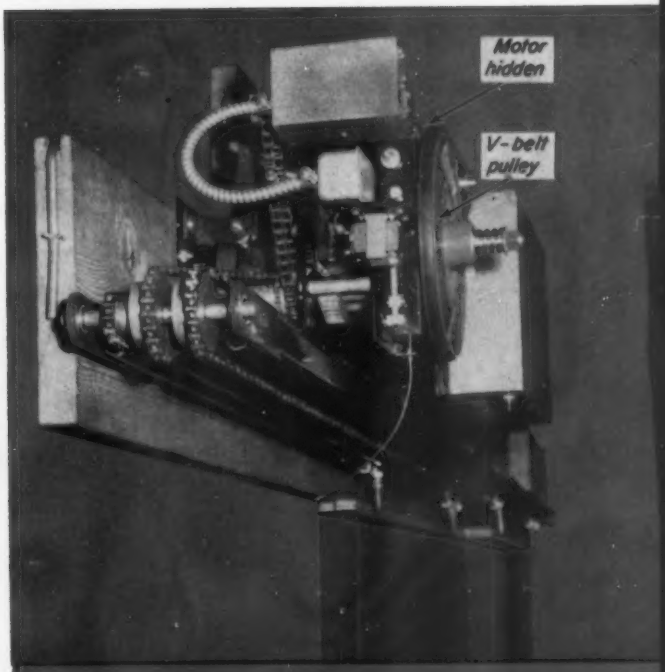
FOOT PEDAL and linkage which lowers flat belt.



SPEED changing position and drive position.







Chain drive solves dual-speed timing problem

CHAIN solves dual speed problem and eliminates misalignment in operating heavy doors in a food processing plant.

The problem was to open and close the pair of doors in 10 seconds. Confined operating space kept the driving motor at one side. Door on the far side had to travel as fast as the near door, both had to meet in door-center at the same time.

The solution is use of dual chains and sprockets. The chain driving the near door travels the shortest distance, hence moves at one-half foot per second on its 9-tooth sprocket.

The chain driving the far door is driven by an 18-tooth sprocket at one foot per second. Both sprockets are driven by a primary sprocket mounted on a shaft. Power driving this shaft is transmitted by a V-belt from an electric, reversible motor to a 10-inch pulley mounted directly on the sprocket-turning shaft.

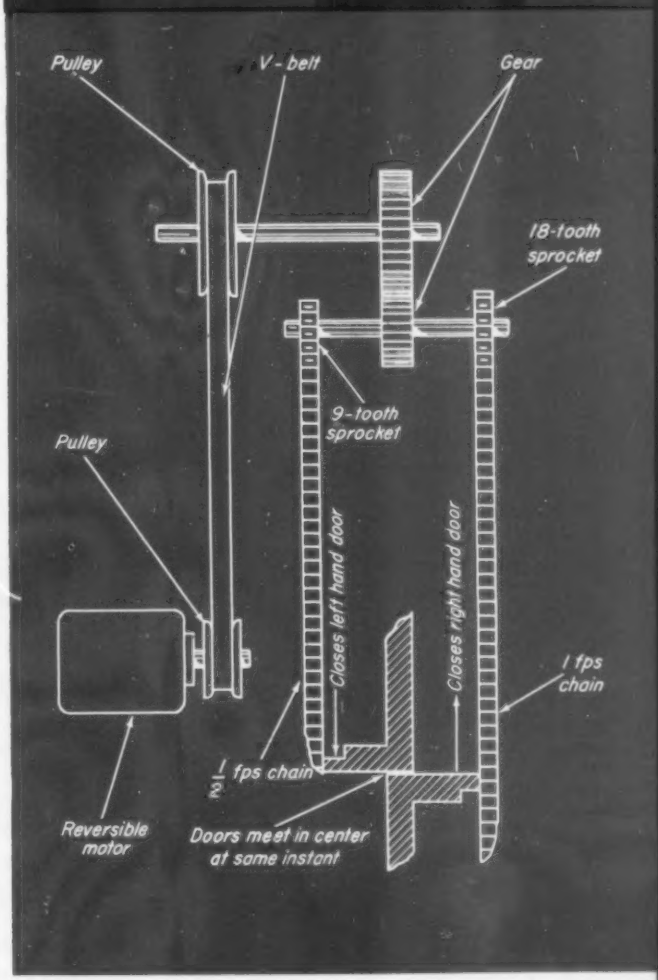
By pressing "Open" and "Close" buttons, plant personnel can activate the doors in 10 seconds.

Several alternative methods of driving the doors are not practical. Using a train of gears creates weight and alignment problems. Lubrication and maintenance problems ruled out a rack and pinion unit. Cables eventually stretch, are in danger of wrapping around each other. Pulleys have size-limits that are overcome by sprockets.

None of these alternatives would produce the speed needed to close the 10-foot door-opening in the specified time.

Chains and sprockets however, give dependable, trouble-free operation. They eliminate the need to line up parts due to uneven walls.

The chain and sprocket drive is the development of *The Clark Door Co., Inc.*, Newark, New Jersey.



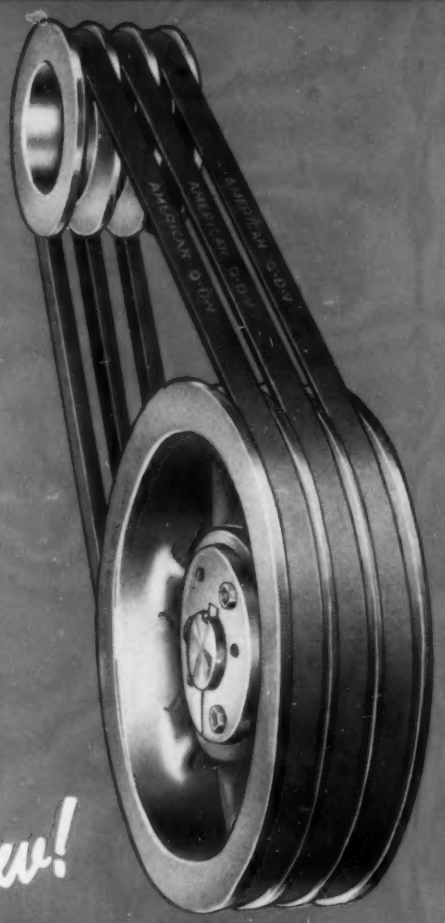
DUAL SPEED problem of driving chains at different speeds from same motor is solved as shown above. Top photograph shows chain drive over doors and doors in closed position. Center photograph shows chain drive and sprockets. Botton drawing shows mechanical drive system schematically.

No. 8. For more information on any component in this article, see page 49

Now American Pulley makes it possible to standardize on the

WORLD'S MOST COMPLETE

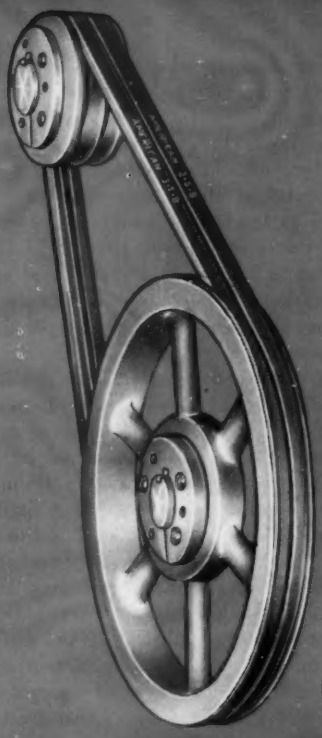
TWO NEW LINES!



New!

AMERICAN Q·D·V DRIVES

Easy mounting. Easy removal. Interchangeable Q-D bushed sheaves for A, B, C and D section belts.



New!

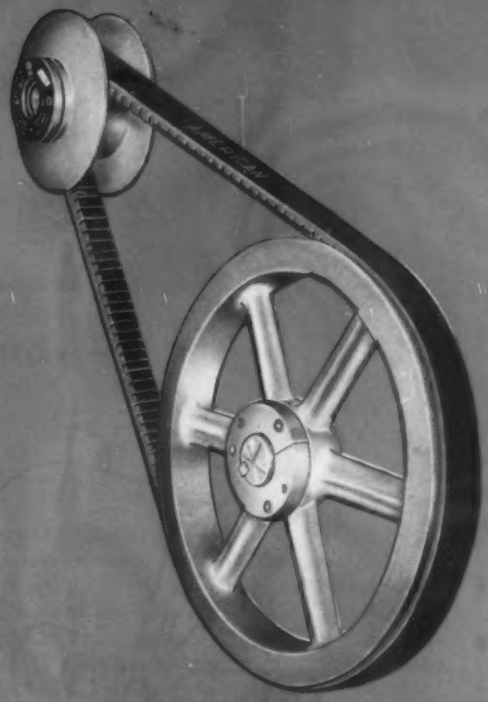
AMERICAN 3·5·8 DRIVES

Compact. Smaller, lighter, Q-D bushed sheaves transmit more hp in less space, at less cost, with fewer belts.

LINE OF V-BELT DRIVES

TWO OLD FAVORITES!

AMERICAN STANDARD ADJUSTABLE-SPEED DRIVES



AMERICAN WIDE RANGE ADJUSTABLE-SPEED DRIVES

Patented double-taper hubs are easy to install, adjust, remove—and *they stay that way!* Positive gripping action. Perfect belt alignment. Standard adjustable-speed sheaves provide infinite adjustment up to 28%. Wide range adjustables permit infinite variations up to 2 to 1.

Get immediate off-the-shelf delivery from your local distributor.

If he doesn't have them yet, write to us. We'll give you the name of the nearest distributor who stocks the complete American Pulley line for your convenience.

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POWER TRANSMISSION DIVISION

THE AMERICAN PULLEY COMPANY

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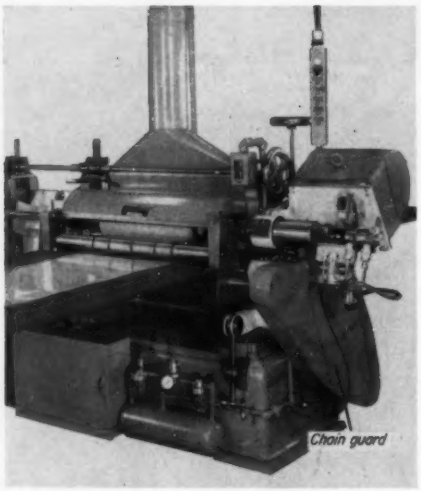
Air cylinder keeps chain tension constant

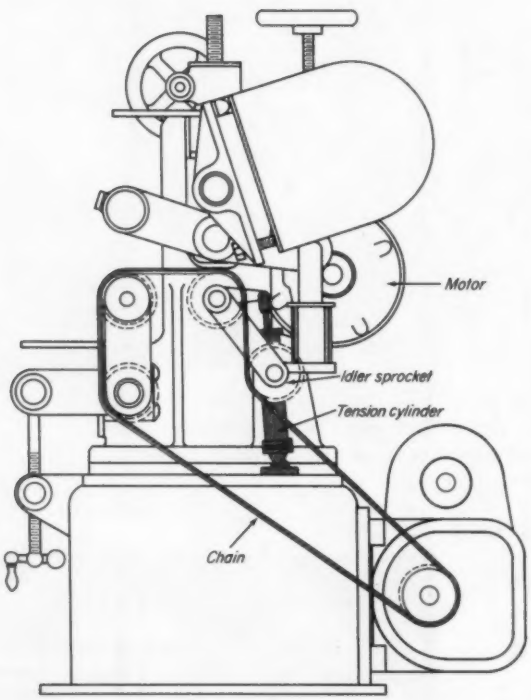


AUTOMATIC CHAIN TENSIONING is provided by an air cylinder on a drive where center distances may change during operation. Three rolls are driven by the chain on surface finishing machine which performs roughing, delustering, polishing and buffing operations. Roll centers may be changed during operation due to variations in thickness of the material being processed, and are changed during setup.

Cylinder is pinned to the machine base so it may pivot. The piston rod connects to crank arm which rotates a sleeve concentric with one of the roll shafts as the piston extends or retracts. Rotation of the sleeve turns another crank arm attached to the sleeve. The idler sprocket is mounted on this arm.

Air pressure to the cylinder is maintained at constant value by a pressure reducing regulator. If the chain starts to slack off, the piston and idler sprocket immediately follow up to maintain tension in the belt. If tension tries to increase, piston and idler back off. Thus, constant tension is maintained over a wide range. There is no change in tension as position changes as there would be with a weight tensioning setup. Compactness is another advantage.

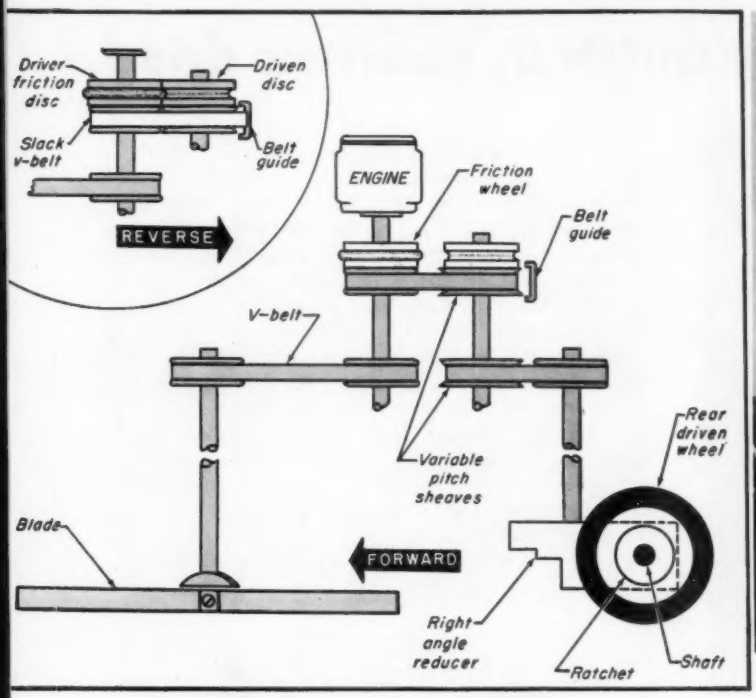
The machine on which this system is installed is made by *Clair Manufacturing Co.*, Olean, N. Y.



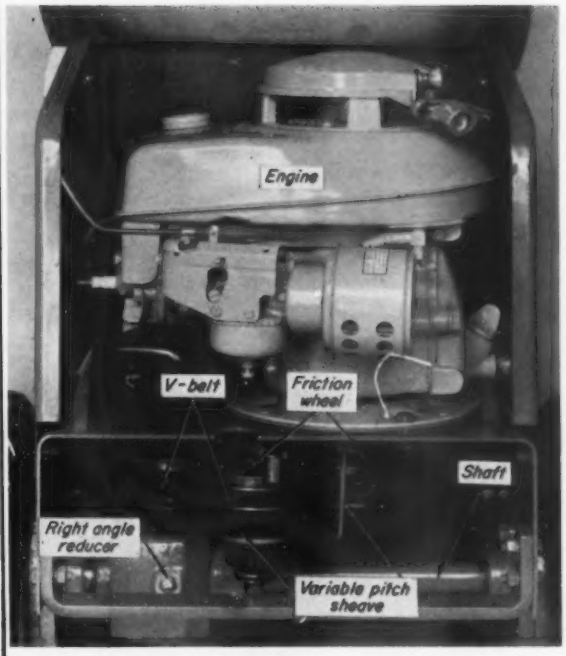
CENTER DISTANCES of three rolls driven by chain and sprockets fluctuates during operation and may be changed during setup. (Above)

CHAIN TENSION is kept constant on this surface finishing machine drive by an air cylinder and pressure-reducing regulator. (Below)

No. 9. For more information on any component in this article, see page 49



FORWARD & REVERSE by use of friction drive.



VARIABLE SPEED through reducers, is obtained.

Wheels go backward, blade forward— with friction drive!

FRICTION DRIVE makes it possible to drive wheels in reverse without changing rotation-direction or speed of the blades on a rotary riding lawnmower.

Mounted on the same shafts as friction discs, two pulleys drive V-belts, one turning the blade's shaft, the other turning the variable pitch sheave governing back-wheel speed.

Thus speed-changes that are directed to rear wheels do not affect the blade speed because blade is driven direct from engine.

Problem facing designers concerned differential action of the rear wheels and the variable speed drive. They had to be able to vary the speed of forward travel while keeping blade-speed constant.

Solution they evolved is: Drive the blade directly from the engine; drive rear wheels with engine, through a variable speed drive.

When cutting heavy grass, blade speed must be constant but mower's forward motion must be slowed to avoid overloading blade. Without the variable pitch drive-unit only the engine speed slowed the mower. It also slowed blade rotation accordingly.

Speed is controlled by a spring-loaded selector with a 2-groove split pulley. Only the pulleys and V-belts give a forward drive to the vehicle.

To go into reverse, the variable speed pulley is moved toward the friction disc. Grooved wheel at end of variable speed assembly engages the disc-edge. The initial drive belt is disengaged by bringing the variable pitch sheaves too close together so that the belt slips off and is held by guides.

The entire pulley and belt drive is then put in reverse rotation. The variable pitch sheave mounted on the motor shaft turns the work-shaft on the rear wheel.

Meanwhile, the blade is still powered direct, at constant speed, by the engine pulley.

When the friction discs are disengaged, V-belt immediately slips into position on the re-positioned variable pitch sheave.

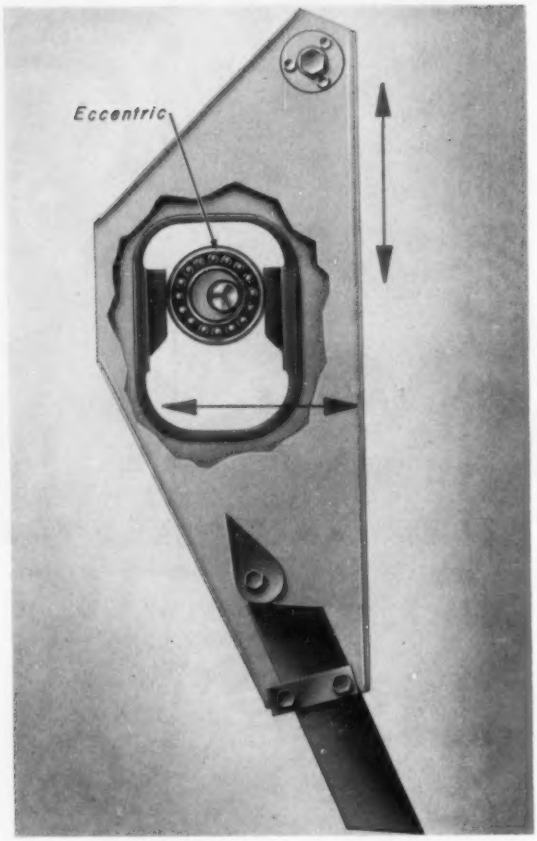
This provides a neutral position between *forward* and *reverse*, and gives a smooth increase in acceleration from *low* to *high* speed.

The result is a mower with a constant blade-speed, rear-wheel speed-variation, and reverse action completed without conventional gear transmissions and differential.

It is the development of the *YUBA Power Products, Inc.*, Cincinnati, Ohio.

No. 10. For more information on any component in this article, see page 49

Ball bearings act as clutch in eccentric drive



ECCENTRIC DRIVE is automatically disengaged when knife support arm is raised because bearing contact surface is cut away.

AUTOMATIC DISENGAGEMENT of an eccentric drive on the knife blade mechanism of a sod cutting machine is performed with two ball bearings.

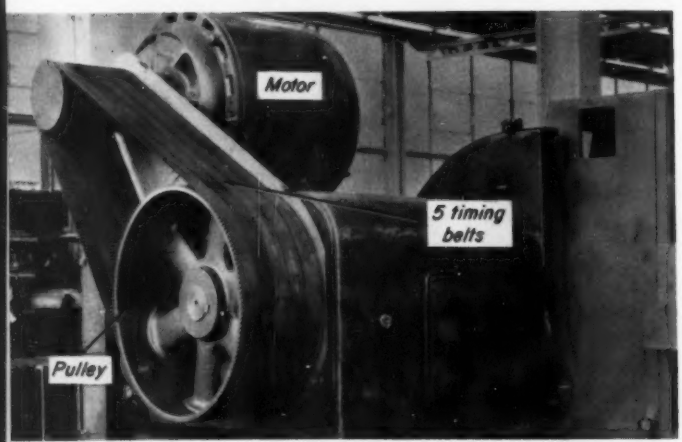
The arms on which the knife is mounted must be raised and lowered to adjust for the different cutting depths for different types of sod and the cuts must be started from the surface. Therefore, the arms must be able to move vertically with respect to the driving eccentrics while they are being driven.

An elongated opening in the support arm is used in which the eccentric fits. An antifriction bearing is used on the eccentric. This lets the arm move vertically with respect to the eccentric while it is being driven. The automatic disengaging is obtained quite simply by cutting away part of the driving surfaces so that when the arm is raised high enough the eccentric and bearing do not make contact.

This machine is designed and built by *Sod-Master Corp.*, Minneapolis, Minn.

No. 11. For more information on any component in this article, see page 49

Timing belt drive reduces sheave diameter



TIMING BELT uses a smaller sized sheave than that used on a V-belt, thus gives economical performance on a circular saw.

Once driven by V-belts, the machine now uses the same horsepower motor even though sheave diameters have been reduced by 30%.

Bearing life has been increased because lessened sheave-weight keeps overhung load on bearings to minimum. Gearlike teeth on belt and pulleys need no lubrication because there is no metal-to-metal contact.

Saw-blade turns at 795 rpm, motor has 75-hp. Timing belt application is on machine manufactured by the *Motch and Merryweather Machinery Co.*, Cleveland, Ohio.

No. 12. For more information on any component in this article, see page 49

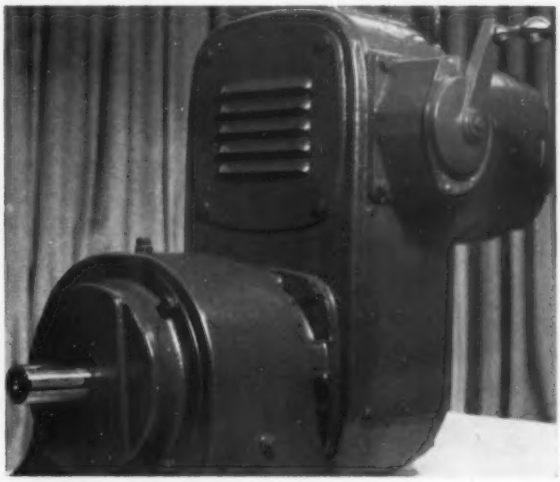
NEW PRODUCTS

Expanded bearing unit line

Wider ball bearing choice is offered by new LF three-bolt and LFT two-bolt precision flange bearing units. Bearing cartridge is permanently mounted in one-piece malleable housing for maximum strength with light weight. Either flush or recessed mounting is provided, with full housing contact under ball path. Precision self-alignment is constant and automatic between bearing OD and housing ID. Centrifugal-labyrinth seals retain pre-lubrication and prevent dirt from entering. Standard sizes: ¾ to 1-7/16 in., ten sizes in all.

Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Aurora, Ill.

Circle No. 100 on the Reader Service Card



Adjustable-speed drive improved

Polydyne drive operates on the principle of V-belt connected, adjustable-pitch pulleys. It is easy to maintain, has accessible controls, and is compact. Actuating force is directed through an equalizer which prevents any binding or sticking of the speed control. Adequate internal clearances without external enlargement make belt replacement easy and belt tensioning is automatic and immediate. Packaged drives are offered from ¼ to 25 hp (a-c) in output speeds from 5 to 4000 rpm, with standard speed variations of 2, 3, 4 and 5 to 1.

General Electric Co., Schenectady, N. Y.

Circle No. 101 on the Reader Service Card

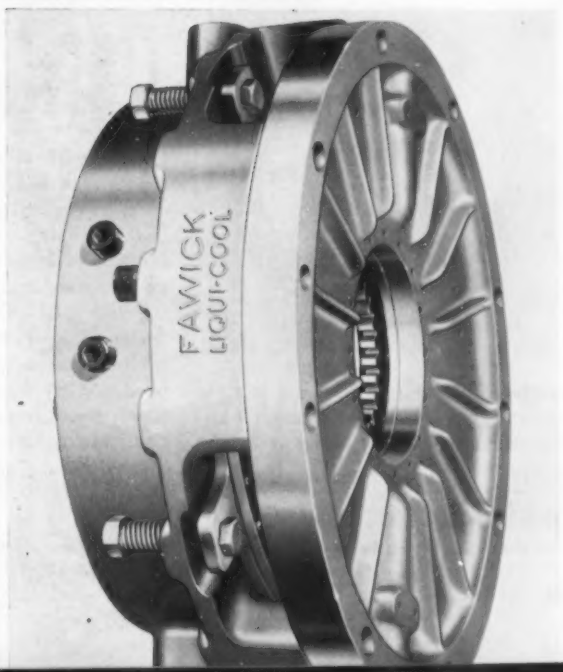
Liquid-cooling process for clutches and brakes

Heat dissipation rates up to 10 times greater than those of conventional water-cooled units are achieved by newly-developed Liqui-cool clutches and brakes. Disc-type power transmission or absorption units remove heat from friction surfaces faster through copper pressure plates which absorb 8 times more energy per square inch of lining area than cast iron plates previously used. Smaller water passage cross section means maximum coolant velocity. Friction wear rates are drastically reduced, long lining life resulting. These features mean that more torque capacity can be built into a given size. Units are especially suited to high-inertia situations where large loads are started and stopped, or constant tension braking and continuous slip cutching where the units give good tension control and horsepower absorption. 5 basic sizes in single or dual disc design; torque ratings from 4500 to 200,000 in.-lbs.

Airflex Div., Fawick Corp., Cleveland, Ohio.

Circle No. 102 on the Reader Service Card

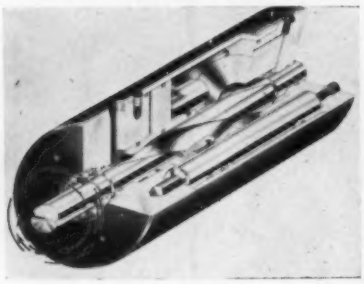
Continued on next page



Continued from preceding page

Rotary actuator

Improved rotary torque actuator. Design has full cushioning for 0 to 370 deg of high torque rotation. Actuator seals dead tight, may be stopped at



any point in cycle. Can be powered by air, gas, water or oil. For standard cycles of 0 to 100 deg, 0 to 190, 0 to 280, 0 to 370, with margins for over-travelling. Bores from 4 to 12 in.

Carter Controls, Inc., Lansing, Ill.

Circle number 103 on reader service card

Double-spring brake

New self-energizing, multiple-spring brake for rugged service on heavy-duty presses. Known as the CT brake, it gives maximum braking power in both rotating directions. Dual springs

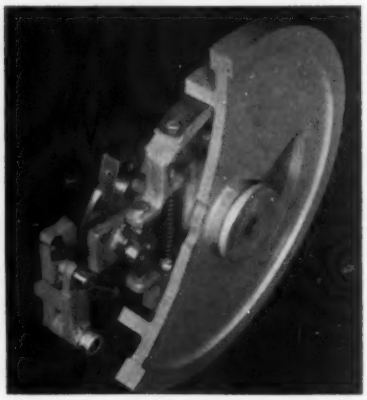
produce brake torque; release is air-actuated. Welded steel trunnion bar design, with generous lining area for given diameter.

Airflex Div., Fawick Corp., Cleveland, Ohio.

Circle number 104 on reader service card

Single-revolution clutch

Features adjustable torque control. Designed for automatic, positive rotation of a shaft from continuously rotating source of power. Ball bearing-equipped flywheel lends itself to V-belt, gear or direct drive with mounting either at the end or in the middle of the shaft. Works for clockwise or counter-clockwise rotation.



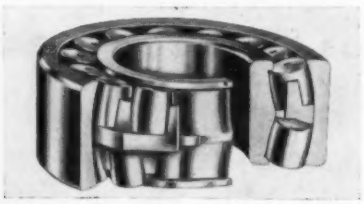
For speeds to 150 rpm, with 1/3 hp rating at 100 rpm. Shaft diameters from 1/2 to 1 in.

Theodore M. Wright, Inc., Camden, N. J.

Circle number 105 on reader service card

Bearings for vibrating screens

High speeds, heavy loads and eccentric shaft motion present special problems for anti-friction bearings



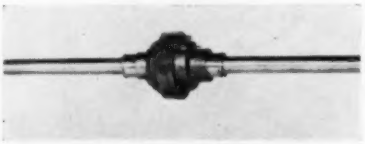
for use with vibrating screens. "C" type screen bearings give high load-carrying capacity and long fatigue life with longer rollers, close conformity of roller and ring contours and separate axially floating ring for effective guiding of rollers. Specially designed one-pice, centrifugally cast bronze cage ensures efficient bearing operation at high eccentricity and speed. Bores from 55 to 160 mm, dynamic load C rating, C, 37800 to 260000 lb.

SKF Industries, Inc., Philadelphia, Pa.

Circle number 106 on reader service card

Small differential

Compact, rugged differential adaptable to many small-vehicle applications, such as garden tractors,



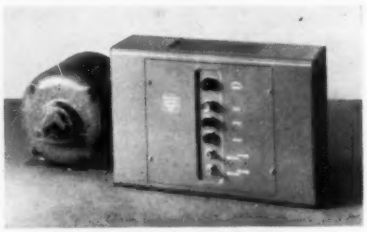
mowers, golf carts, midget racing cars, etc. 10 hp rating. Assembly permits mounting of sprocket, pulley or gears. Hubs provided for anti-friction bearings. Alloy steel axle shafts can be machined at point of use. Alemite grease fitting for lubrication when mounted externally. Can also be run in oil inside a differential case.

Warner Automotive Div., Borg-Warner Corp., Auburn, Ind.

Circle number 107 on reader service card

Adjustable-speed drives

New line in 1/6 to 10 hp range. Drives use magnetic amplifier unit-driving thyratrons in full wave cir-



cuit, followed by d-c shunt motor. Speed ranges of 100:1 and regulation percentages of 1—2% without tachometer feedback. Flexible modular construction lets user select particular features needed.

Cleveland Machine Controls, Inc., Cleveland, Ohio.

Circle number 108 on reader service card

Multi-purpose lubricant

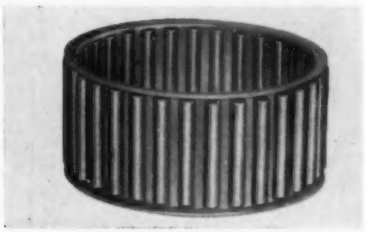
Known as Keystone No. 88, product applies to 90 percent of ball and roller bearing installation, according to manufacturer. High-film-strength, lithium base makes it resistant to damp atmospheres or direct contact with water. Does not thin out under heat or pressure. Operating temperature range of 0 to 275 deg, six densities available.

Keystone Lubricating Co., Philadelphia, Pa.

Circle number 109 on reader service card

Needle bearings

Roller-cage assemblies meet space restrictions for applications like idler gears, planetary gears, seaming rolls or any locations where shaft and housing surfaces can be hardened and ground. Needle assemblies use



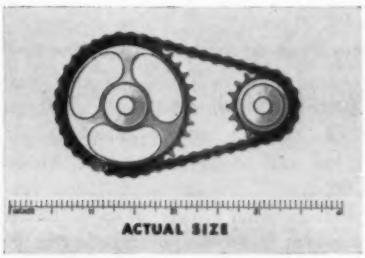
1/8 in. diameter precision ground rollers, permanently aligned in pockets or bronze cages centered on housing surface. Cage-guided rollers cannot skew or misalign. 18 sizes, choice of two lengths, for shaft diameters from 1/2 to 2 in.

Orange Roller Bearing Co., Inc., East Orange, N. J.

Circle number 110 on reader service card

Micropitch bushing chain

Extremely fine pitch chain combines high strength and high resistance to joint wear with minimum size and



weight. Permits an infinite variety of shaft centers. Multiple shafts can be accurately timed because sprockets may engage both sides of the chain. Specially applicable in electro-mechanical equipment, communications devices, cameras, data processing machines, etc.

Diamond Chain Co., Indianapolis, Ind.

Circle number 111 on reader service card

Low torque brake

For accurate tension control in low torque range. Low torque diaphragm brake has low inertia and comes equipped with linings to withstand

Continued on next page

GERBING

VARIABLE SPEED DRIVES
and Flexible Couplings

Widest Choice of Drive Arrangements and Speed Ratios... all V to V

All Gerbing variable speed pulleys utilize the efficient V to V operating principle which allows the use of a V-groove driven sheave. This offers greater effective pulling power, vibrationless transmission of power, and long belt life. HP ratings are from fractional through 25 @ 1750 RPM. Speed is adjusted by a mere turn of the handwheel. Speed-change ratios up to 8 to 1 may be obtained without stopping the motor. Built for years of trouble-free operation. Electric or mechanical remote controls are also available.

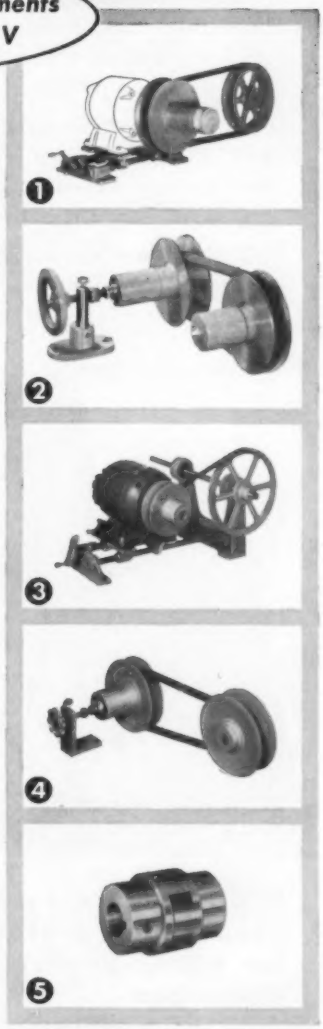
1 ROTO-CONE
- Sizes from 1/8 to 25 HP.
- Speed ratios up to 4 to 1.
- V-belt travels on fixed center line.
- Easily installed.
- Used with standard or countershaft adjustable motor bases.

2 ROTO-DRIVE
- Speed ratios up to 8 to 1.
- No adjustable motor base needed.
- Consists of 2 Roto-Cone pulleys.
- Save up to 40% over conventional drives.

3 VAR'A'CONE
- For all 'A' and 'B' belt drives.
- 1/3 thru 1 HP.
- Ratios up to 2¾ to 1.
- Through shaft mounting.
- No interlocking discs.

4 VAR'A'CONE Fixed Center Drive
- Two Var'A'Cones — one manually operated.
- Up to 7½ to 1 speed-change ratio.
- Fixed shaft centers.
- No adjustable motor base needed.

5 FLEXIBLE COUPLINGS — Cushion Type
- 3 Models
- From fractional to 700 HP
- No lubrication
- For details — request a copy of Flexible Couplings Bulletin



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The installation of the latest type of automatic machine tools and equipment in our new plant has greatly stepped up production compared to our previous smaller manufacturing facilities in Northbrook, Illinois.

- **MOTOR BASES** — complete selection of standard and countershaft adjustable.
- **VARIABLE SPEED BELTS...**
- **COMPANION SHEAVES...** Available from distributor and factory stocks.

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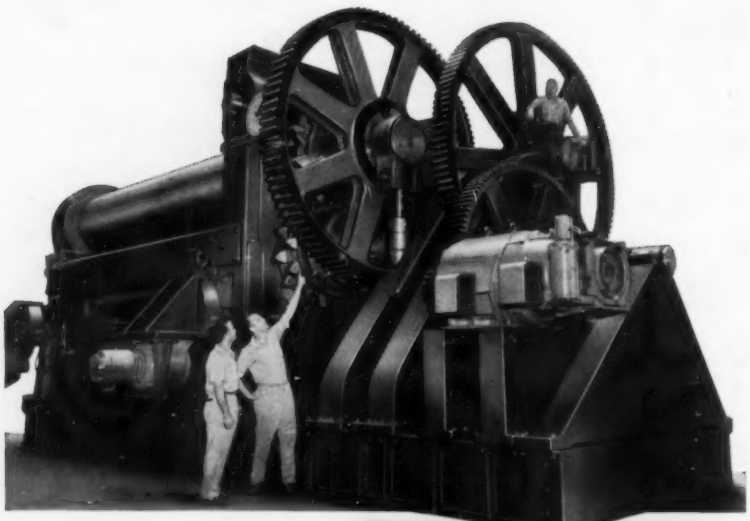
Huge H&S Gears

drive world's largest bending machine

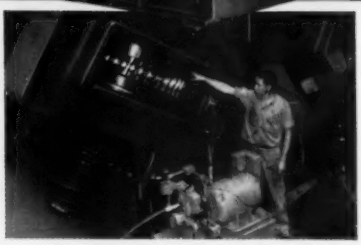
Horsburgh & Scott is proud to have supplied the spur gears that drive this machine—designed and built by Bertsch & Co., Cambridge City, Indiana. Largest of its kind, it bends cold steel plates up to 4¼ inches thick, 16 feet long; weighs over ¾ of a million pounds.

Horsburgh & Scott has facilities to generate gears up to 125″ diameter and to form-mill spur gears up to 160″. We have a complete industrial gear line including worm, helical and herringbone speed reducers.

Tell us your needs. We'll be glad to help you select the proper gearing for you.



2100-ton pressure shapes hull plates for atomic-powered submarines



H & S bronze worm gears adjust forming rolls

Send for your free copy of H & S Gear Catalog No. 57.

THE HORSBURGH & SCOTT CO.

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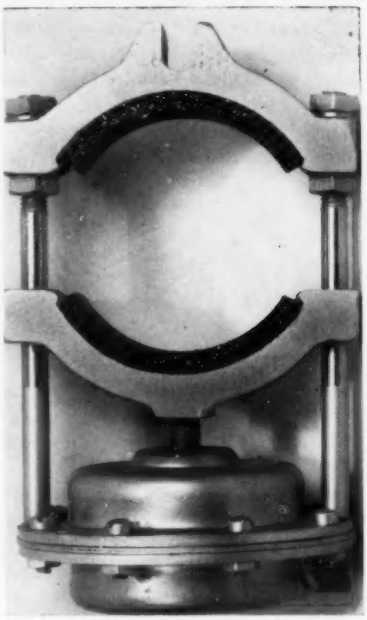


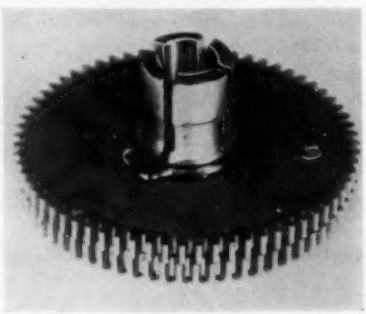
high temperatures and speeds up to 2000 rpm. Easy installation, requires only one holding pin. Ideal for applications requiring 400 in.-lb torque or less, or where small intermittent or constant drag is needed to prevent over-running. Psi ratings from 10 to 100.

Horton Mfg. Co., Inc., Minneapolis, Minn.

Circle number 112 on reader service card

Anti-backlash gears

Spring-loaded miniature gears for servo and instrument design. Overall length 5/16 in. in clamp-on version. Internal spring is used. Floating gear is prewound and restrained. Assembly meshed by displacing floating portion tooth. 96 pitch, size range 66 to 110 teeth. Bores .090, .120 and .125.



Precision Mechanisms Corp., East Meadow, N. Y.

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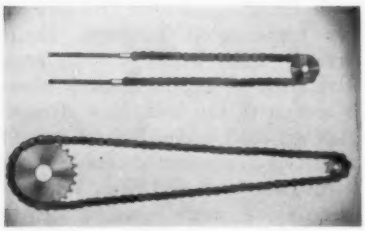
Miniature chains, sprockets

Mechanical chains and sprockets permit motion to be transferred simultaneously through several planes without complicated gearing or cable slippage. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, elec-



tronic devices and small precision instruments. Wider tolerances, less weight and maintenance. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 in. Chain pitch .1475 in., weight .45 oz per lineal foot. Made of stainless steel and other materials, including non-magnetic beryllium copper.

Sierra Engineering Co., Sierra Madre, Calif.

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Bearing retainers

New line of fiber-glass-filled nylon retainers for needle thrust bearings. Made in non-standard sizes to individual specifications up to 3 in. bore. Lower tooling costs for new sizes,

with special economies in short-run or low-volume bearing uses. Life and load ratings identical with steel retainers. Now in use for automotive steering gears, automatic transmissions, hydraulic pumps, tractor bolsters and gear boxes.

Torrington Co., Torrington, Conn.

Circle number 115 on reader service card

Continued on next page

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UNLIMITED COMBINATIONS POSSIBLE

Acme Conveyor Chains and Attachments meet the present day need for greater speed and durability on your automatic machines — they offer smoother running operation that costs less to buy and less to maintain.

Acme Chains always keep their original accuracy and uniformity of pitch because of their high tensile strength and wear resisting properties of the hardened pins and bushings.

Prove these facts for yourself by investigating the many advantages Acme Conveyor Chains and Attachments offer you. Consult your local Industrial Distributor today, he has the full cooperation of our technical engineering department to help solve your problem.

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HOLYOKE MASSACHUSETTS

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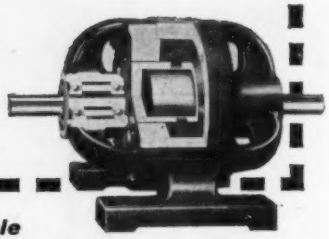
VICKERS®

MAGNECLUTCH™



The most versatile and dependable clutch for power transmission and torque control . . . MAGNECLUTCHES lick the toughest application problems

The Vickers MAGNECLUTCH consists fundamentally of two rotating concentric cylinders coupled by dry magnetic particles under the influence of a magnetic field. With no direct contact between clutching surfaces, there is no wear; life of the MAGNECLUTCH is exceedingly long. Torque is easily regulated by varying the magnetizing coil current.

Unlike all other industrial clutches, torque transmitted is independent of speed. Since starting and running torques are the same, there is no grab or chatter during acceleration or braking periods; operation is extremely smooth. Torque is transmitted at zero slip with 100% mechanical efficiency. MAGNECLUTCHES have a broad range of operating speeds, provide torque limiting, fast response, and can be easily and remotely controlled.

The many unique features of MAGNECLUTCHES make them the most versatile and dependable clutches available, whether for tension control, cycling (start-stop) operation, torque limiting, controlled acceleration, wind-up, starting of high inertial loads, or constant torque transmission. ***Write for Bulletin 6000A***

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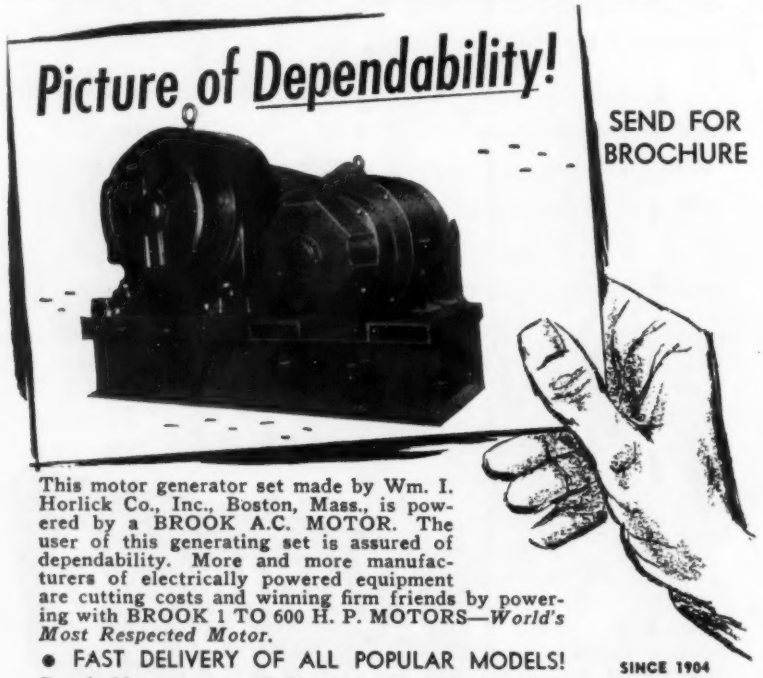

This motor generator set made by Wm. I. Horlick Co., Inc., Boston, Mass., is powered by a BROOK A.C. MOTOR. The user of this generating set is assured of dependability. More and more manufacturers of electrically powered equipment are cutting costs and winning firm friends by powering with BROOK 1 TO 600 H. P. MOTORS—*World's Most Respected Motor.*

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Continued from preceding page

Multiple V-belts

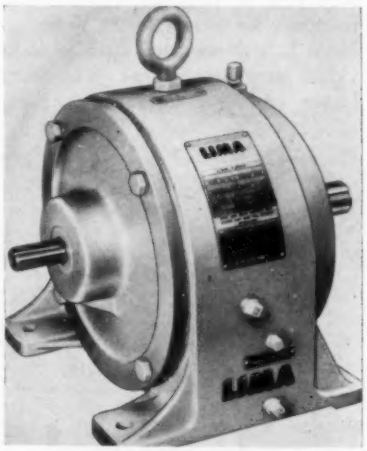
New belts are claimed to set increased standards of power transmission, with more hp in given area, at less cost, and with fewer belts, smaller and lighter sheaves and shorter center distances. DA 358 belts have increased sidewall area which, together with domed top, frees entire sidewall for transmission purposes. Entire area is under compression from placement of tensile member above V-section of the belt. New strength member used makes for 40 percent reduction in number of cross-sections needed for multiple drives. With accompanying, more compact sheaves up to 50 percent of overall drive width is saved, reducing bearing loads and weight. Manufactured in 3v, 5v and 8v sizes.

Durkee-Atwood Co., Minneapolis, Minn.

Circle number 116 on reader service card

Speed reducer

Straight line reducers, foot mounted, flange mounted, or with extended housing. 5.06:1 to 1478:1 ratios, .077 to 147 hp capacities, output speeds from .49 to 350 rpm. Permanent alignment with extra-rigid cast housings of unit case design protecting against overhung loads, uneven



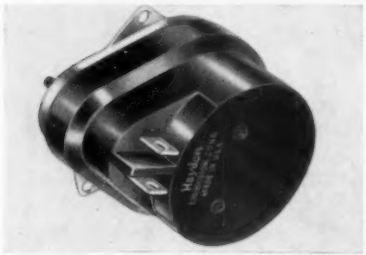
mounting surfaces or accidental impact. Ratio may be changed, or unit inspected, by simple removal of endbell without disconnecting reducer from load.

Lima Electric Motor Co., Lima, Ohio.

Circle number 117 on reader service card

Improved timing motor

Moisture-proof and low-cost for chart drives, timing devices, similar applications in instrumentation field. Motor capsule offers extra protection against corrosive atmospheres in chemical and processing plants, being completely covered and sealed. Motor is heavy-duty, synchronous type with guaranteed torque of 30 oz-in. at 1 rpm. Synchronization main-



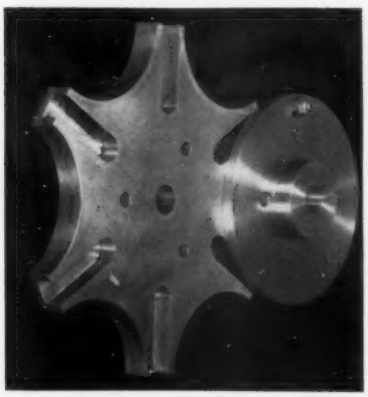
tained from 103 to 132 v a-c. Models for 120 or 240 v operation at 50 or 60 cps. Standard shaft speeds between 1/60 and 60 rpm.

Haydon Div., General Time Corp., Torrington, Conn.

Circle number 118 on reader service card

External geneva drives

For conversion of rotary to intermittent or indexing motion for geneva applications. Indexing, smooth and positive in either direction, up to 2,000 indexes per minute. Locking after each indexing is accurate



within .001 in. Entering of cam follower at start of each cycle is consistently smooth. Center distances from 1 to 24 in.

Geneva Motions Corp., Clearwater, Fla.

Circle number 119 on reader service card

Continued on next page

For more information on any components discussed in the feature or idea articles in this issue, fill out and mail blank below. This applies only to those articles referring to this page.

EDITOR, POWER TRANSMISSION DESIGN *JULY*, 1959
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....
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(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....
FIRM .....TYPE BUSINESS .....
ADDRESS ..... STATE.....

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EDITOR, POWER TRANSMISSION DESIGN *JULY*, 1959
812 HURON ROAD, CLEVELAND 15, OHIO

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(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....
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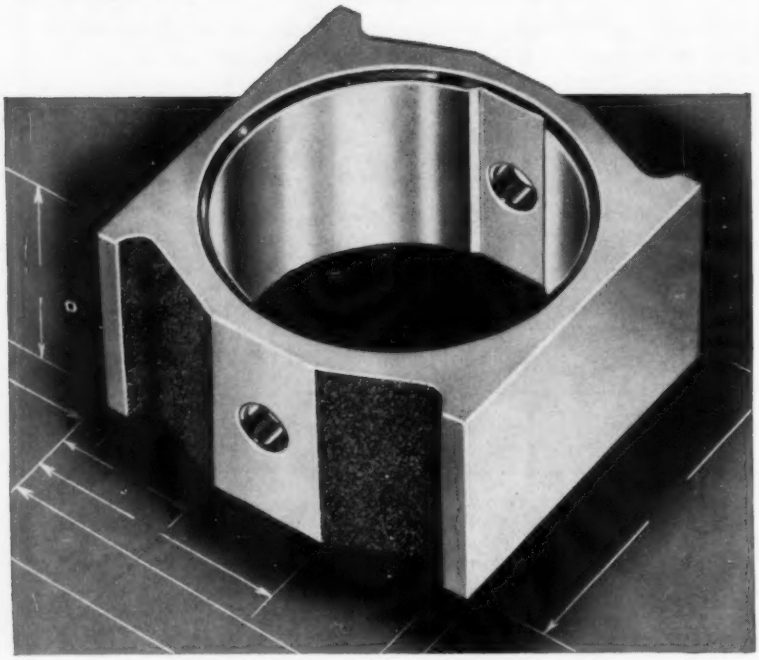
many difficult requirements...



We illustrate the cast bronze cam block for a hydraulic pump operating the hydraulic lift mechanism on an exceedingly well-known line of farm tractors.

The manufacturer of this equipment has very unusual specifications for this cam block. Its bore has a very fine finish specification. It also must be round and true to size within unusually close limits. In addition, it must be square to the face of the cam block within limits that ordinary methods of manufacture will not attain.

Bunting methods of manufacture result in a part which is completely to the customer's exacting specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered metal, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

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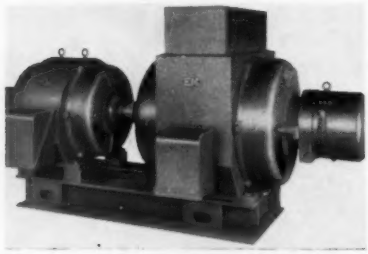
BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

For more information circle No. 5 on the Reader Service Card

Continued from preceding page

Motor generator set

400-cycle set for within-plant operation. Special noise limiting features:



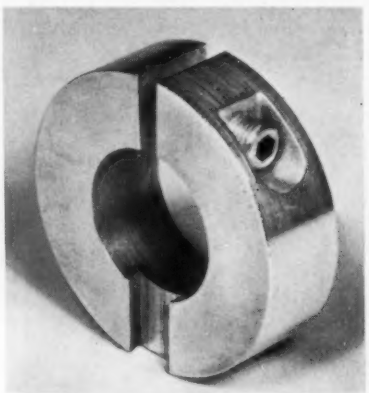
generator is ventilated straight up, noise paths within generator are acoustically lined, and special rotor slot wedges are used to reduce windage noise. Synchronous, 150-hp, 1200-rpm motor, 220/440 v, 3 phase. For magnetic, reduced voltage starting. Generator has 125 KVA rating at 0.8 P.F.

Electric Machinery Mfg. Co., Minneapolis, Minn.

Circle number 120 on reader service card

Shaft collar

Transmits torque up to allowable stress limits of low carbon rolled steel shaft, thrust loads exceeding rating of some types of roller thrust bearings, without use of conventional



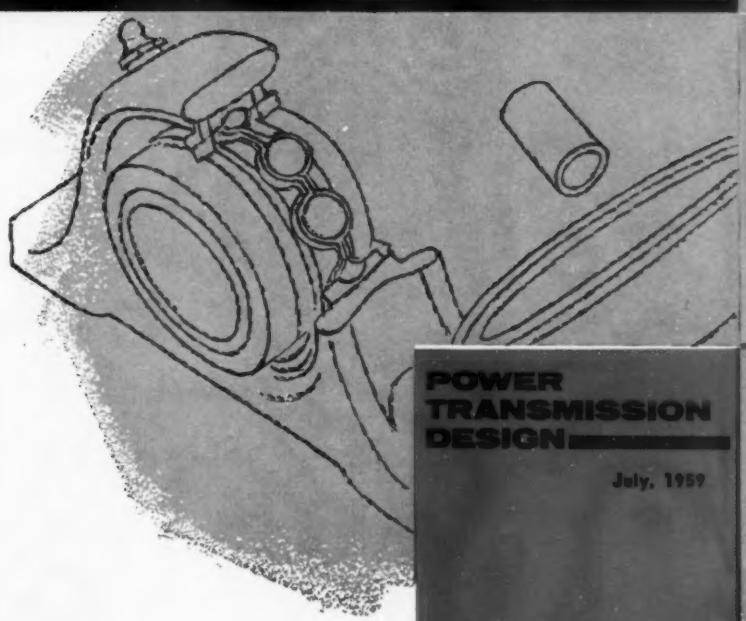
shaft keys, splines, shoulders, etc. Wrench is only assembly tool needed. Collar is spring-locked to shaft with grip equivalent to a shrink fit, will not work loose even under severe vibration. Sizes to fit commercial cold-rolled steel shafts from ¾ to 2 in. Available (besides torque collar type shown) is thrust collar type without dovetail slot across face.

Kolock Products Co., Lutherville, Md.

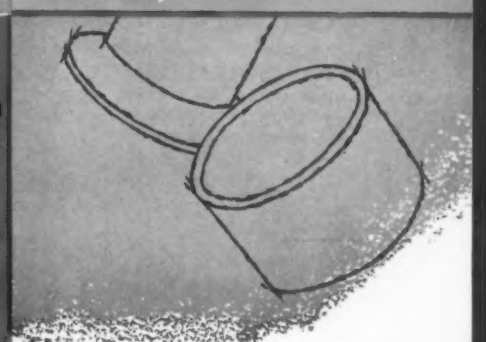
Circle number 121 on reader service card

BEARINGS

DESIGN/APPLICATION



REGULAR MONTHLY
SECTION OF IDEAS
AND DEVELOPMENTS



POWER
TRANSMISSION
DESIGN

July, 1959

How to compute

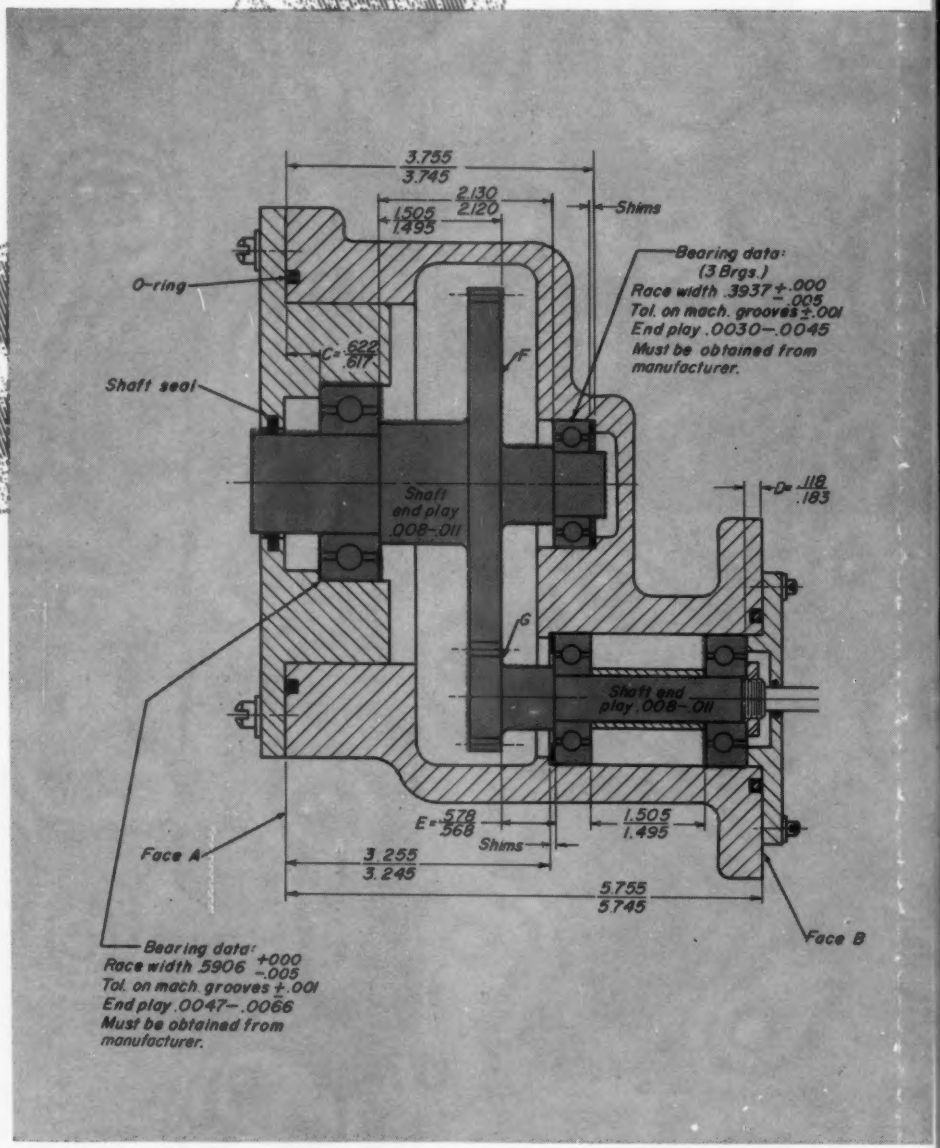


FIG. 1. SIMPLIFIED gear train has shaft end-play controlled. Follow computations in article.

You must know amount of bearing end-play . . .
You must know amount of bearing face mis-match . . .
You must know bearing race width . . .

tolerance stack-up on gear trains

By WALTER BOBAK,
product engineer, Thompson Ramo Woolridge Inc.

A STEP BY STEP SUMMATION of tolerances prevents crossing of signs or doubling up of the same figures. Chart forms or addition and subtraction of mean dimensions with tolerance additions cannot be used in a critical tolerance analysis. No set rules can be applied to short-cuts.

Common Method

Consider a simple bearing and shaft assembly as shown in Fig. 2. The data used can be obtained from standard bearing handbooks. Normal tolerances are applied.

The unknown quantity is dimension *A*. This is the length of the bearing stop pilot.

Calculate a combination of dimensions that will assemble satisfactorily. That is, determine a maximum stack-up of parts that will fit into a minimum space.

If you do it by the common method, the answer for the maximum length of pilot *A* is .490. This is calculated by

3.495 min, seat to housing face
—1.000 max, bearing widths
2.495
—2.005 max, length between shoulders on shaft
.490 max, length *A* of pilot

This indicates that when the combination of tolerances are in the worst condition, the maximum stack-up across the outer races is equal to the minimum space determined from the length of the pilot diameter and the depth of the housing bore. If this condition were to exist in an actual assembly, the shaft would have to play equal only to the end play of the bearings.

Let us assign a working tolerance to the length of pilot *A*. The maximum end play can then be determined as follows

Let pilot length $A = .490 - .480$
3.505 max, seat to housing face
— .990 min, two bearing widths
2.515
1.995 min, length between shoulders on shaft
.520
— .480 min, length *A* of pilot
.040 max, clearance of assembly.

From this, the maximum end play of the shaft is .040 plus the internal end play of the shaft.

In order to point out the errors in the preceding tolerance analysis, we must first discuss the factors involved in the making of, and tolerances applied to, ball bearings.

Must Know Bearings

In the example, it was assumed that the tolerances on the bearings applied to the envelope dimensions. This cannot be assumed. In some cases, bearing handbooks state that the tolerance applies only to bearing race widths.

To accomplish a thorough tolerance analysis, the geometry of the bearing for the worst stack-up condition must be known to determine the maximum and minmum conditions.

Consider the configuration of a single outer race, with tolerance as shown in Fig. 3. The width tolerance of the race is what is normally found in handbooks. However, prior to machining the race grooves, the individual races are made to vary within the set tolerance. When the grooves are machined, they are centered into the mean of the high dimension to some tolerance which is plus or minus some figure for locating the groove center. This indicates that when the bearing race is at its minimum width, and the groove is machined to its maximum position with respect to one face, the center of the groove with respect to the other face is at a minimum dimension.

The same is true with inner races. At assembly, the inner and outer races are assembled indiscriminately. This can produce, and often does, a stagger or mis-match of the faces as shown in Fig. 4.

Continued on next page

Mis-Match of Faces

The envelope dimension of bearings must therefore be increased by the amount of mis-match.

The groove radii in the races is larger than the radius of the balls. In addition, a certain amount of radial clearance is designed into the bearing. A combination of the two produces internal end play which is measured as the amount of axial movement of the inner race with respect to the outer race. You must know this for a good tolerance analysis.

Correct Method

Let us use the same dimensions used in the first example to compute a correct tolerance stack-up keeping in mind the geometry of the bearings as explained

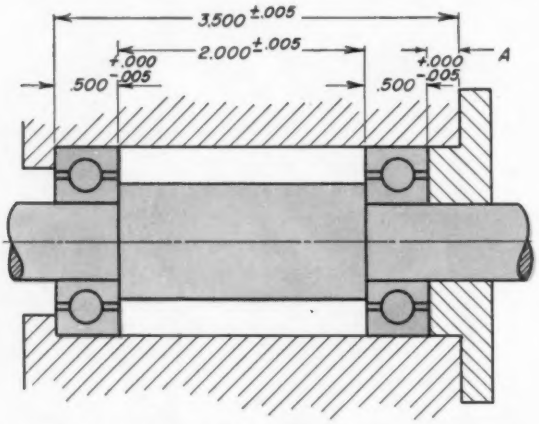


FIG. 2. DIMENSION *A* is length of bearing stop pilot and must be determined.

above. End play values will not be included. Here is the way the computations should be worked out.

Maximum stack-up of parts is

- .007 max, mis-match of bearing faces
- .495 min, race width—Caution: minimum width is used in this maximum stack-up because .007 max mis-match occurs when race width is minimum.
- 2.005 max, between shoulders on shaft
- .495 min, race width
- .007 max, mis-match of bearing faces
- 3.009 max, across outer races of bearing and shaft assembly

Minimum stack-up of space is

- 3.495 min, bearing seat to housing face
- — .490 max, length *A* of bearing stop pilot
- 3.005 min, space
- —3.009 max, stack-up of parts
- — .004 interference max

The minus .004 inches indicates there is a greater stack-up of parts than there is space. This means that the bearings will pre-load on assembly. With end play less than plus .004, bearings will gall.

To correct this, do a stack-up applying the correct geometry of the bearing using the information from Fig. 2. Determine max length bearing stop pilot *A*.

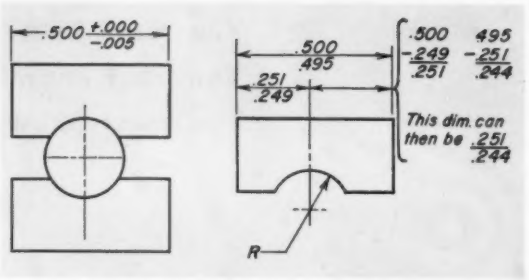
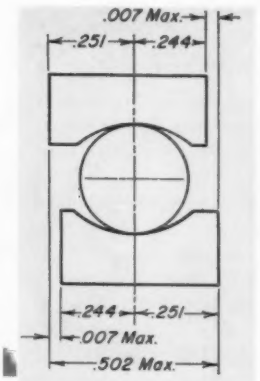


FIG. 3. WIDTH TOLERANCE of outer races can be found in handbooks.

You will find that the pilot length will be .004 inches shorter than the previously determined length. This eliminates the possibility of interference fit and pre-loading.

Critical Stack-Up

It is important that, for critical shaft end-play stack-ups, more data on bearings must be made available to designers and engineers by manufacturers. These are end play, magnitude of face mis-match and face width.



In this diagram the ball is centered in the center of the grooves which means the outer race can move in either direction axially with respect to the inner race a distance of one-half of the bearing end play.

FIG. 4. MIS-MATCH OF FACES must be obtained from manufacturer.

Let's do a tolerance analysis on the large gear train shown in Fig. 1 and control shaft end play.

Determination of Dimension C

.58560	min	bearing race widths		.59060 max
— .00700	max	mis-match of inner and outer races	+ .00200	max
.57860	min	across corners of bearing		.59260 max
— .00330	max	one-half of bearing end-play	— .00235	min
.57530	min	across corners with play out		.59025 max
2.12000	min	length between bearing shoulders		2.13000 max
.38870	min	bearing race width		.39370 max
3.08400	min			3.11395 max
— .00700	max	mis-match of outer and inner races	+ .00200	max
3.07700	min			3.11595 max

− .00225	max	half of bearing end play	− .00150 min
3.07475	min	across outer races with play out	3.11445 max
.01100	max	total shaft end play req'd	.00800 min
3.08575	min	distance req'd across outer races to obtain desired end-play	3.12245 max
3.74500	min	distance from face A to seat	
−3.12245	max	distance across races	
.62255	max	length *C* permissible	

Therefore $C = .622 - .617$

Determination of Shims

3.75500	max	distance from face A to seat	3.74500 min
− .61700	min	length of stop pilot *C*	− .62200 max
3.13800	max	space between outer race shoulders	3.12300 min
−3.08575	min	distance across outer races	−3.12245 max
.05225	max	Shims required to produce .008 to .011 end play	.00055 min

Following is how great end-play could become if no shims were used

.05225	max	shimming requirement	.00055 min
.01100	max	end play accounted for	.00800 min
.06325	max	Shaft end play with no shims	.00855 min

Determination of Pilot D

.38870	min	bearing race width	.39370 max
− .00700	max	mis-match of outer and inner races	+ .00200 max
.38170	min	across corners of outer to inner race	.39570 max
− .00225	max	one-half of bearing end play	− .00150 min
.37945	min	across corners of bearing with play out	.39420 max
1.49500	min	length of spacer between bearings	1.50500 max
1.87445	min		1.89920 max
.37945	min	across corners of bearing with play out	.39420 max
2.25390	min	across outer races with play out	2.29340 max
.01100	max	total shaft end play required	.00800 min
2.26490	min	distance across outer races to obtain desired end play	2.30140 max
5.74500	max	over-all length of housing	
−3.25500	max	from face A to bearing seat	
2.49000	min	distance from face B to bearing seat	
−2.30140	max	distance across faces	
1.8860	max	length of D permissible	

Therefore $D = .188 - .183$

Determination of Shims

5.75500	max	overall length of housing	5.74500 min.
−3.24500	min	distance from face A to seat	−3.25500 max
2.51000	max		2.49000 min
− .18300	min	length of bearing stop pilot *D*	− .18800 max
2.32700	max	space between outer race shoulders	2.30200 min
−2.26490	min	distance across outer races	−2.30140 max
.06210	max	Shims required to produce .008 - .011 end play	.00060 min

It is shown from the range of shims required on the two shafts that the tolerance accumulation will cause considerable mis-match of the gears axially.

Upper Shaft Assembly

.62200	max	length of pilot C	.61700 min
.59060	max	bearing race width	.58560 min
1.21260	max		1.20260 min
+ .00200	max	mis-match of outer and inner races	− .00700 max
1.21460	max	face A to shoulder on shaft	1.19560 min
− .00235	min	half of bearing end play	− .00330 max
1.21225	max	face A to shoulder with play out	1.19230 min
+ .01100	max	gap representing end play with bearing play out	+ .00000 min
1.22325	max		1.19230 min
1.50500	max		1.49500 min
2.72825	max	face *A* to gear face *F*	2.68730 min

Lower Shaft Assembly

5.75500	max	overall length of housing	5.74500 min
− .18300	min	length of pilot *D* on bearing stop	− .18800 max
5.57200	max		5.55700 min
− .38870	min	bearing race width	− .39370 max
5.18330	max		5.16330 min
+ .00700	max	mis-match of outer and inner races	− .00200 max
5.19030	max		5.16130 min
+ .00225	max	half of bearing end play	+ .00150 min
5.19255	max		5.16280 min
.00000	max	gap representing end play with bearing play removed	− .01100 max
5.19255	max		5.15180 min
−1.49500	min	spacer between bearings	−1.50500 max
3.69755	max		3.64680 min
− .38870	min	inner race width	.39370 max
3.30885	max	face *A* to shoulder on shaft	3.25310 min
2.68730	min	face *A* to gear face *F*	−2.72825 max
.62155	max	gear face F to shoulder on shaft	.52485 min

$$\text{Average of above} = \frac{.62155 + .52855}{2} = .57320$$

Make $E = .578 - .568$

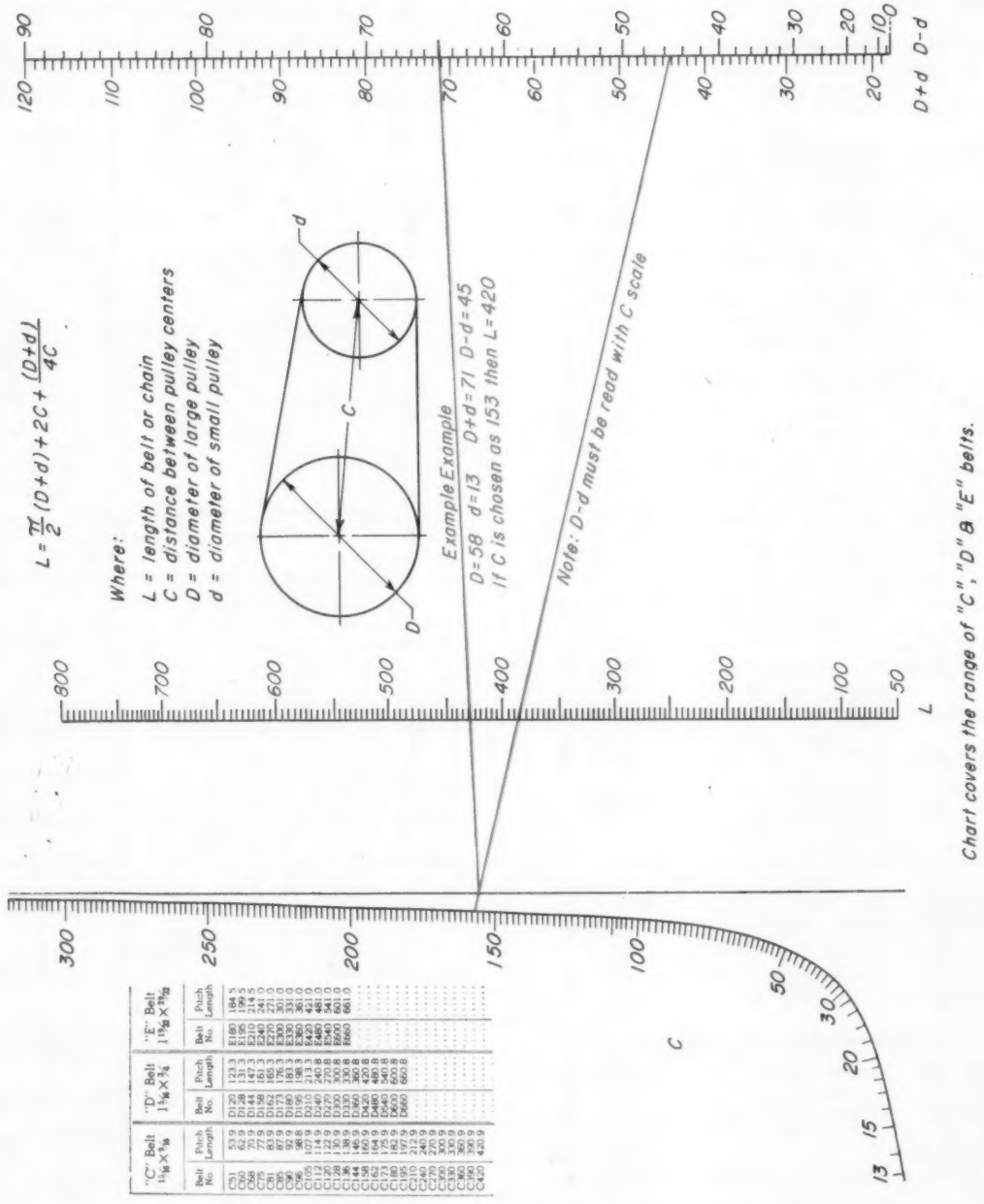
3.30885	max		3.25310 min
− .56800	min	shoulder on shaft to gear face *G*	− .57800 max
2.74085	max	face *A* to gear face *G*	2.67510 min
−2.68730	min	face *A* to gear face *F*	−2.72825 max
.05355	max	mis-match of gear faces	− .05315

If gear faces are .365 min, actual gear contact is .365 − .053 = .312 min.

REFERENCE FILE

Nomogram of C, D, E belt or chain length

By GEORGE B. RICHTER, *University of Minnesota*


$L = \frac{\pi}{2}(D+d) + 2C + \frac{(D+d)}{4C}$
Where:
L = length of belt or chain
C = distance between pulley centers
D = diameter of large pulley
d = diameter of small pulley
Example
D=58 d=13 D+d=71 D-d=45
If C is chosen as 153 then L=420
Note: D-d must be read with C scale
D+d
D-d
L
C
d
D
Chart covers the range of "C", "D" & "E" belts.

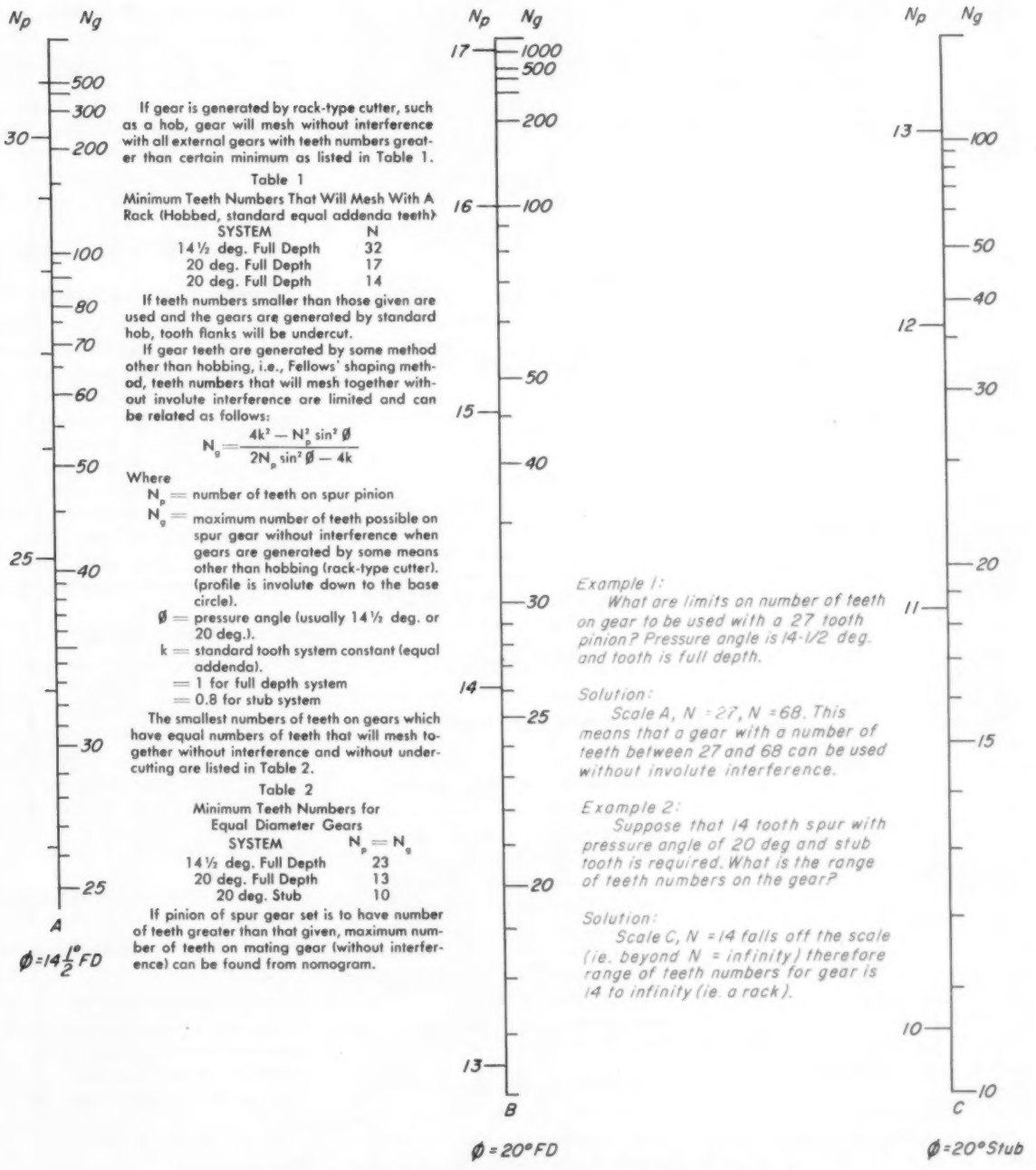
"C" Belt 13/16 × 5/8		"D" Belt 1 1/4 × 3/4		"E" Belt 1 15/32 × 7/8	
Belt No.	Pitch Length	Belt No.	Pitch Length	Belt No.	Pitch Length
C51	53.9	D120	123.3	E180	184.5
C60	62.9	D144	147.3	E195	199.5
C75	77.9	D158	161.3	E240	241.0
C81	83.9	D162	165.3	E270	271.0
C90	92.9	D180	183.3	E300	301.0
C96	98.8	D195	198.3	E330	331.0
C105	107.9	D210	213.3	E360	361.0
C112	114.9	D240	240.8	E420	421.0
C120	122.9	D273	270.8	E540	541.0
C128	130.9	D300	300.8	E600	601.0
C144	146.9	D360	360.8	E660	661.0
C158	160.9	D420	420.8		
C162	164.9	D480	480.8		
C173	175.9	D540	540.8		
C180	182.9	D600	600.8		
C210	212.9	D660	660.8		
C240	240.9				
C270	270.9				
C300	330.9				
C360	360.9				
C420	420.9				

For a free reprint, circle No. 250 on the Reader Service Card

Nomogram of involute gear teeth number

By J. N. ARNOLD, *professor, and*

ALLAN C. DUNK, *assistant professor, Purdue University*



If gear is generated by rack-type cutter, such as a hob, gear will mesh without interference with all external gears with teeth numbers greater than certain minimum as listed in Table 1.

Table 1

Minimum Teeth Numbers That Will Mesh With A Rack (Hobbed, standard equal addenda teeth)

SYSTEM	N
14½ deg. Full Depth	32
20 deg. Full Depth	17
20 deg. Full Depth	14

If teeth numbers smaller than those given are used and the gears are generated by standard hob, tooth flanks will be undercut.

If gear teeth are generated by some method other than hobbing, i.e., Fellows' shaping method, teeth numbers that will mesh together without involute interference are limited and can be related as follows:

$$N_g = \frac{4k^2 - N_p^2 \sin^2 \phi}{2N_p \sin^2 \phi - 4k}$$

Where

N_p = number of teeth on spur pinion

N_g = maximum number of teeth possible on spur gear without interference when gears are generated by some means other than hobbing (rack-type cutter). (profile is involute down to the base circle).

ϕ = pressure angle (usually 14½ deg. or 20 deg.).

k = standard tooth system constant (equal addenda).

= 1 for full depth system

= 0.8 for stub system

The smallest numbers of teeth on gears which have equal numbers of teeth that will mesh together without interference and without undercutting are listed in Table 2.

Table 2

Minimum Teeth Numbers for Equal Diameter Gears

SYSTEM	$N_p = N_g$
14½ deg. Full Depth	23
20 deg. Full Depth	13
20 deg. Stub	10

If pinion of spur gear set is to have number of teeth greater than that given, maximum number of teeth on mating gear (without interference) can be found from nomogram.

Example 1:

What are limits on number of teeth on gear to be used with a 27 tooth pinion? Pressure angle is 14-1/2 deg. and tooth is full depth.

Solution:

Scale A, N = 27, N = 68. This means that a gear with a number of teeth between 27 and 68 can be used without involute interference.

Example 2:

Suppose that 14 tooth spur with pressure angle of 20 deg and stub tooth is required. What is the range of teeth numbers on the gear?

Solution:

Scale C, N = 14 falls off the scale (ie. beyond N = infinity) therefore range of teeth numbers for gear is 14 to infinity (ie. a rack).

For a free reprint, circle No. 251 on the Reader Service Card

LITERATURE on drives and components

Source-book for oil seals

Victoprene oil seals, having hardened steel cases, synthetic rubber elestomers and garter springs, are suitable to most shaft applications, whether rotational, oscillatory or reciprocating. 56-page engineering catalog 305 describes types of seals available, gives design, application, installation and maintenance information. Also a helpful glossary of SAE nomenclature and a complete catalog of specifications of seals available. Heavily illustrated with pictures, tables and diagrams.

Victor Mfg. & Gasket Co., Chicago, Illinois.

Circle number 200 on reader service card

Stock sprockets

Illustrated 19-page catalog gives complete listing of sprockets and flexible couplings for roller chains. Full dimensions, prices, mounting and dismounting instructions and other engineering data. Hub-type, plate-type and fixed bore sprockets included. Catalog 100B.

Acme Chain Corp., Holyoke, Mass.

Circle number 201 on reader service card

Precision ball bearings

Bearings for instruments, aircraft accessories, computers and recorders and other precision applications are described in a readable, attractive 8-page catalog, C-1. Tolerances, characteristics and application suggestions are given, along with full lists of bearing available. Many illustrations included.

Barden Corp., Danbury, Conn.

Circle number 202 on reader service card

Bearing line

Fifty-two-page reference catalog gives information on ball thrust, roller thrust and journal roller bearings. Ball thrust styles include flat seat and spherical seat, single and double direction. Both English and metric dimensions are given. Catalog 20 is usefully illustrated.

Ball and Roller Bearing Co., Danbury, Conn.

Circle number 203 on reader service card

Bearing material

Chemloy 719 is a newly-developed bearing material primarily for dry running, borderline lubrication or for operations in a corrosive environment. Material is non-metallic, has extremely low coefficient of friction. Operates in either liquid or gaseous environments and requires no lubrication. Illustrated bulletin lists tubes, rods and sheets available.

Crane Packing Co., Morton Grove, Ill.

Circle number 204 on reader service card

Control starter

Features and benefits of new 0 to 4 control line are given in 6-page, illustrated bulletin 14B9182. Design features and field modifications of the basic starter are covered, along with special-design and accessory devices.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Circle number 205 on reader service card

Gearing applications

Worm gear drives and applications to power transmission are shown in Bulletin 145, 16 pages, profusely illustrated. Sections on vertical and multiple-reduction units, right-angle reducers, helical attachments, integrated assemblies, etc.

Cleveland Worm & Gear Co., Cleveland, Ohio.

Circle number 206 on reader service card

Automatic variable speeds

Automation through Varitrol control units is outlined in 8-page illustrated booklet 1797. Of interest to designers and management, coverage includes engineering angles and broad field of economic factors. Typical applications are colorfully presented.

U. S. Electrical Motors, Inc., Los Angeles, Calif.

Circle number 207 on reader service card

Fractional horsepower motors

Bulletin 450 describes re-rated fractional horsepower motors in NEMA frames 56 and 48. Effectively illustrated in color, discussion includes polyphase, split phase, capacitor start and permanent split capacitor styles. Full design data given on each component part.

Robbins & Myers, Inc., Motor Div., Springfield, Ohio.

Circle number 208 on reader service card

Eddy-current equipment

Dynamatic couplings, drives, brakes are presented in 15-page bulletin GB-3. Emphasized are Ajusto-Spede packaged drive units in fractional and integral horsepower ranges. Magnetic-friction clutches and brakes are also inclued in concise form.

Eaton Mfg. Co., Dynamatic Div., Kenosha, Wis.

Circle number 209 on reader service card

Variable-speed equipment

Revised 28-page illustrated bulletin 3100, 1959 edition, describes complete line of all-steel, helical gear and integral Motoreducers. Lines have been redesigned to incorporate rerated NEMA motors from 1 to 75 hp. Bulletin retains detailed information on unit size and construction, how to select proper size and ratio, installation and accessories data, etc.

Falk Corp., Milwaukee, Wis.

Circle number 210 on reader service card

Compression packings

Teflon, a chemically inert, low-friction material, is featured as compression packing substance. It can be used as material from which packing is formed, or in liquid form as impregnant lubricating seal. This, and other standard substances, are described in applications to sealing for many conditions in 20-page illustrated booklet.

E. F. Houghton & Co., Philadelphia, Pa.

Circle number 211 on reader service card

Ball screws and splines

Illustrated catalog 58 covers design standards and conditions, typical installations, dimensions and technical data on Beaver ball screws and ball splines.

Beaver Precision Products, Inc., Clawson, Mich.

Circle number 212 on reader service card

Carbon-graphite for parts

Karak carbon-graphite is a versatile, non-metallic material suitable for pump seals, packing rings, thrust and annular bearings, fluid coupling seals, and other applications. It is inert, non-contaminating and self-lubricating. Useful illustrated brochure gives full information on characteristics and uses.

The Ohio Carbon Co., Cleveland, Ohio.

Circle number 213 on reader service card

Motors, rotating devices

New catalog shows complete line of small a-c motors and rotating devices for military and commercial uses. Servo and gear motors, induction and synchronous motors, alternators, generators and others are included.

Rotating Components, Inc., Brooklyn, N. Y.

Circle number 214 on reader service card

Speed reducers

Fifteen-page, well-illustrated bulletin 5908 contains engineering information and specifications on Speed-Master line of vertical-helical gear reducers. Double and triple reduction units.

Western Gear Corp., Industrial Products Div., Belmont, California.

Circle number 215 on reader service card

Screw conveyor drives

Four sizes cover most industrial applications. Drives complete with speed reducer, packing gland and drive shaft, mounted together. Each size available in 3 ratios, 3 to 1 single reduction gearing, 8 to 1 or 18 to 1 double reduction gearing. 16-page bulletin A667C, illustrated.

Dodge Mfg. Corp., Mishawaka, Ind.

Circle number 216 on reader service card

New ball source

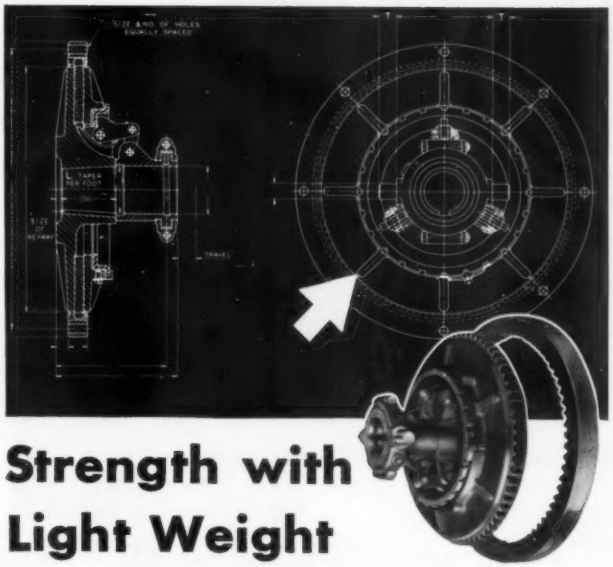
Price list and descriptive booklet introduces new line of mirror finish chrome steel Micro-Balls, recently on the market. Company manufactures balls from 1/4 to 19/32 in., in four AFBMA grade standards.

Micro-Ball Div., Berthelsen Engineering Works, Joliet, Ill.

Circle number 217 on reader service card

Continued on next page

ROCKFORD



Strength with Light Weight for Heavy-Duty Work

Ribbed construction, in ROCKFORD HE Over-Center CLUTCHES, provides strength, without undue weight, to the clutch body and pressure plate. Driving pressure is applied toward the outside of the facing to assure that ROCKFORD CLUTCHES will continue to pull their full rated load during their long service life—particularly in power take-off applications. The load is carried by teeth on the outside diameter of the facing member. While your power transmission control projects still are in the planning stage, it will pay you to consider how this ROCKFORD CLUTCH will provide added strength with less weight.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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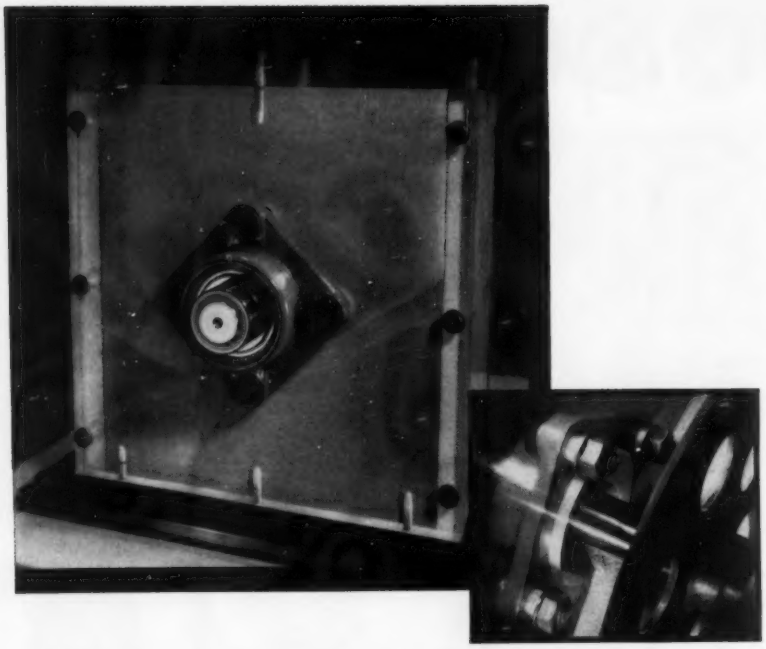
CLUTCHES

For more information circle No. 18 on the Reader Service Card



WOOD'S NEW LABYRINTH-SEALED "LIFE-LUBE" BEARINGS LAST NEARLY *6000 HOURS* IN EMERY DUST BLAST

Wood's new "Life-Lube" bearings recently were "blasted" to destruction in emery dust to test their capacity to hold up under the most adverse operating conditions. These permanently lubricated, ball bearing pillow blocks and flange units were sealed in torture chambers in which the atmosphere contained an extremely high concentration of rapidly agitated, finely divided emery abrasive. Fully ⅓ of the exposed bearings were actually buried under this fine abrasive. Their average life was 5909 hours . . . a remarkable span in these gruelling tests.

Continuing tests such as these, and the millions of "Life-Lube" bearings in service, demonstrate the dependable, economical service available from these precision-made permanently lubricated units. Their seals are not just close-running shields, but rubbing seals with flexible sealing lips running in contact with inner rings. These synthetic rubber seals form labyrinths with close-fitting steel caps which fling away foreign particles. Grease stays in . . . dirt out. Maintenance is sharply reduced.

Wood's "Life-Lube" pillow blocks, flange and take-up units are equipped with standard high capacity MRC 200 series ball bearings which allow unrestricted alignment in any direction. Pillow blocks and flange units are available in shaft sizes from ½ to 2 15/16 inches. Take-up bearings from ¾ to 2 7/16 inches.

Write for Bulletin 7100.

Woods

T. B. WOOD'S SONS COMPANY
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For more information circle No. 28 on Reader Service Card

Continued from preceding page

Compact motor line

Eight-page illustrated bulletin GEA-6927 describes new Thinline motor, rated from 1 to 5 hp in dripproof and totally enclosed constructions for limited space applications such as machine tools, fans, blowers and food disposers. Includes product features, chart of interchangeable flange dimensions, and installation data.

General Electric Co., Schenectady, N. Y.

Circle No. 218 on Reader Service Card

Sprockets and chains

Comprehensive, illustrated 88-page catalog on sprockets and chain drives has both stock part and engineering application information. Details on 1300 stock sprockets and various types of roller chains, plus useful tables and graphs.

Cullman Wheel Co., Chicago, Ill.

Circle No. 219 on Reader Service Card

Speed control units

Motor control systems for remotely controlling speed of dc motors from ac power source. Manual and automatic models, packaged including motors, are described in 6-page illustrated brochure. Half-wave models from 1/50 to ½ hp, full-wave models from ¼ to 3 hp, with various speed ranges and power source voltage choices.

Electro Devices, Inc., Paterson, N. J.

Circle No. 220 on Reader Service Card

Transmission belting

Extremultus belts have polymer interior tensile member covered with chrome tanned leather friction surface. Leather thus carries no load, can be tanned to give maximum coefficient of friction without regard to strength or stretch properties. Greater horsepower per inch width for high speeds and high-capacity loads with unusual belt compactness. Well-illustrated 10-page booklet shows present applications, supplies detailed specifications and application data.

Extremultus, Inc., Long Island City, N. Y.

Circle No. 221 on Reader Service Card

Letters to the Whatzzit Contest

What is Whatzzit Contest?

Whatzzit contest is an opportunity for you, readers of POWER TRANSMISSION DESIGN, to pass along ideas you've had in the back of your minds for a long time that could help yourself or someone else work out power transmission problems.

Two Types of Entries

Your entries may be:

(1) An idea representing something you could build into actual hardware if you wanted to but have never had reason or need to do so.

(2) An idea of some mythical thing you could use, if it were available, and which you have never seen or heard of on the market.

For instance, a type 1 idea might be a simple design of a journal bearing made of organic fibers you work with in a textile mill, and you feel have tremendous frictionless properties if only someone would try them out as a bearing.

A type 2 idea might be a design of a 9-speed gear box that you could use in your work, if one existed, but which you've never seen or heard about.

Whatzzit Contest Rules

Whatzzit contest letters should be addressed to:

Whatzzit . Contest
% The Editor
POWER TRANSMISSION DESIGN
812 Huron Road,
Cleveland 15, Ohio

Entries should include a penciled sketch of the idea on any kind of paper and a brief description in 100 words or less. No formality is required. An honorarium of $5.00 will be paid only for those actually published. Only a few can be used each month selected on the basis of idea originality and possible end usefulness. All entries become the property of Power Publishing Co., Cleveland, Ohio. Publication is not an endorsement of workability or guarantee of statements made. Contest is offered only as a means of stimulating ideas and rendering service to others who may be able to apply these ideas to end uses.

Entry Type 1— **WANTED:**

Interchangeable drives for extensible conveyors?

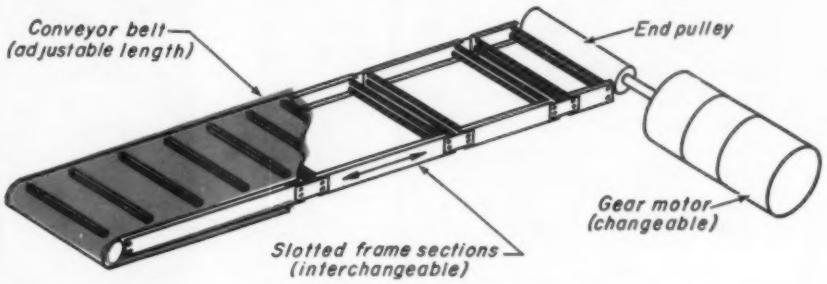
An inexpensive conveyor kit that can be purchased with different types of belting (flat, bucket, ribbed, etc.) and a choice of gearmotor drives (1/4 hp at 250 fpm, 1/3 hp at 10 fpm, etc.). Kit would have various section lengths (12, 24, 36, 48 feet, etc.).

Conveyor may thus be lengthened or shortened easily. Load, speed and situational demands may be met with simple adaptations of the basic assembly without great expense.

The frame-work would be of strong slotted steel, easily assembled or dismantled.

Small plants particularly would benefit from the versatility of the conveyor and the economy of adaptation.

R. S. Wood
General Manager
Kendrick & Davis Co.
Lebanon, N. H.



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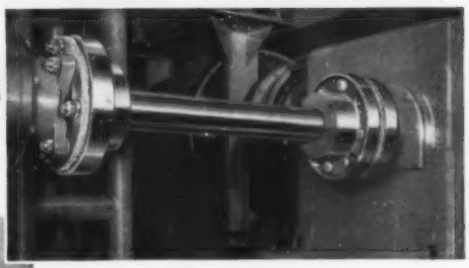

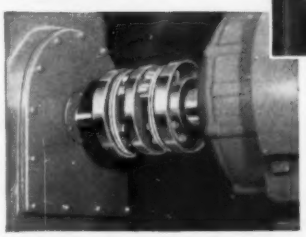

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2 Free End Float
3 Smooth, Continuous Drive with Constant Rotational Velocity
4 Visual Inspection While in Operation
5 Original Balance for life
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THOMAS FLEXIBLE COUPLING COMPANY
WARREN, PENNSYLVANIA, U.S.A.

For more information circle No. 22 on Reader Service Card

Which variable-speed dc drive?

BY MARK H. SLUIS, *electrical engineer, Pratt & Whitney Co.*

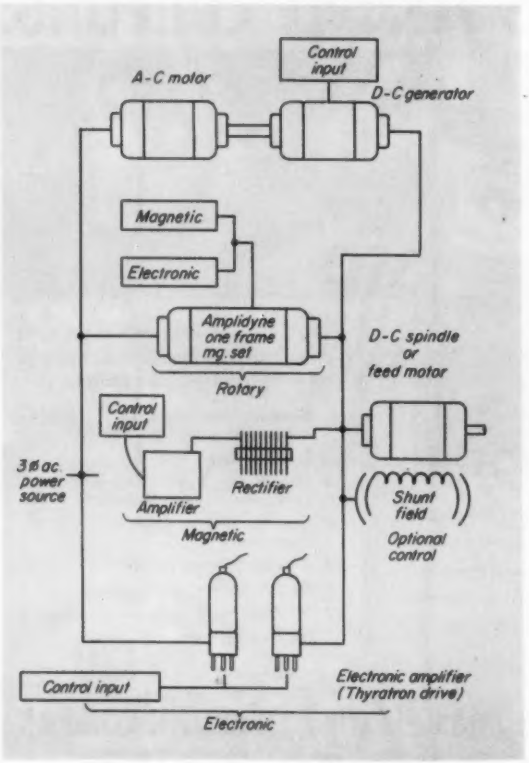
THREE CONTROL SCHEMES are widely used for varying speeds of dc motors. Each uses controlled amplification where a small signal causes a proportional change in the high-level dc output to the motor. The amplifying methods can be labelled: rotary, magnetic and electronic, Figure 1.

In choosing from these three types, some of the relative factors to be considered are: reliability, maintenance, gain, speed of response, signal-power voltage, whether the device has low or high impedance, power range, efficiency, cost, size, and weight.

Control includes the ability to accommodate wide speed changes, acceleration, deceleration, and regulation or maintenance of speed settings with varying load conditions. In a self-regulating system, the gain is a measure of error signal amplification. Speed of response is a measure of time for the system to adjust itself to a new set of conditions (usually expressed in cycles of the ac supply). Gain and response speed oppose each other and a compromise is usually necessary.

The drives to be discussed are of the variable-voltage type as far as the dc drive motor is concerned. Power conversion from a three-phase ac source is assumed.

FIG. 1. ROTARY, MAGNETIC, AND ELECTRONIC dc drives use the same three-phase power input and dc motor on the output end.



Rotary Amplifiers

Rotary amplifiers are of three general types: the variable-voltage drive, or MG set, the armature reaction generator, and the tuned field generator. Most common MG set is the Ward Leonard where a constant-speed prime mover, generally an ac motor, drives a dc generator to supply a dc motor. The generator field can be controlled in a number of ways to vary generator power output. Control power is from 1 to 10% of load power. The lower figure is for larger machines.

Field control may range from a hand-operated rheostat to magnetic or electronic regulators. Regulators might, in turn, be controlled by feedback. Total response time of several stages of amplification is proportional to the arithmetic sum of individual time delays. Total gain, on the other hand, increases geometrically. By cascading until a sufficient gain reserve is available, some gain can be traded for more rapid response.

Magnetic Amplifiers

These operate like synchronous switches to let current flow during a preset portion of the ac cycle, Figure 2. Impedance of the reactor drops instantaneously to zero at this preset time and returns to a high value when the current passes through zero. The mag-

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This article is abstracted from a paper presented at the Design Engineering Conference, ASME, Philadelphia, Pa., May 25-28, 1959.

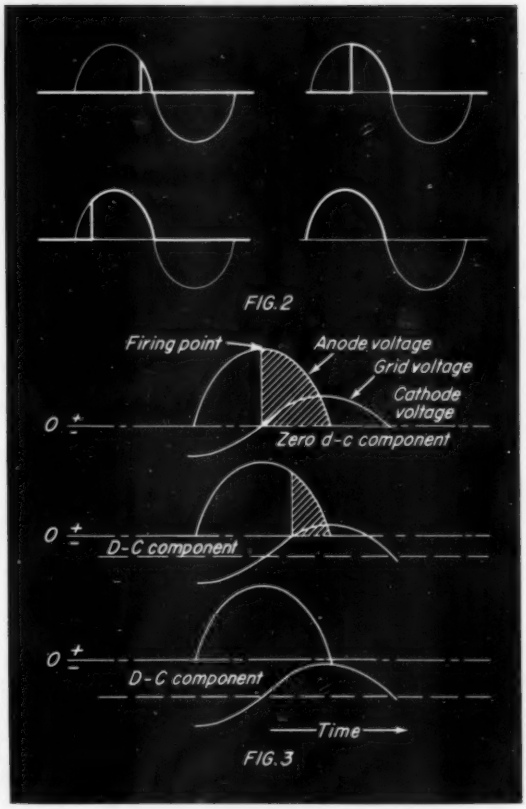


FIG. 2. MAGNETIC AMPLIFIERS control the portion of an ac cycle during which current flows. A dc bias determines when conduction starts.

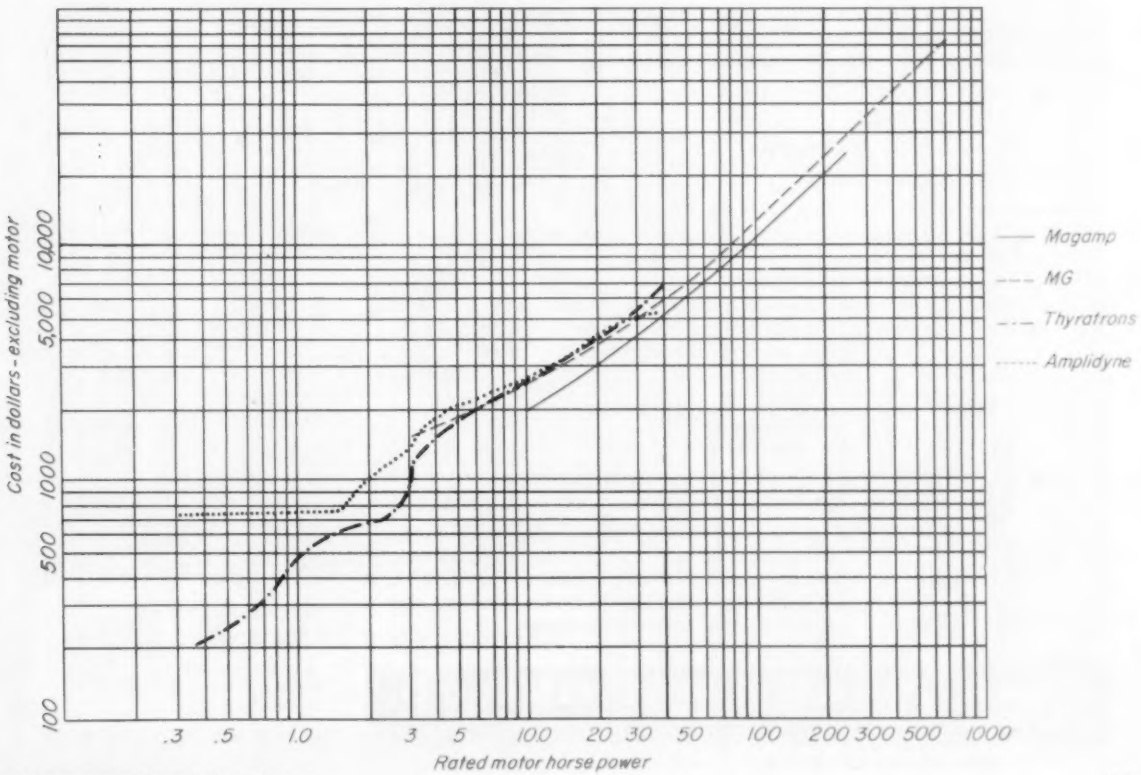
netic amplifier therefore acts like a controlled impedance in series with the load. When controlling a dc motor, a bridge-type rectifier would be used in series with the magnetic amplifier to change the ac output to dc. External means such as transistor, vacuum tube, or another magnetic amplifier may be used to raise error signals to a level suitable for operating the magnetic amplifier.

Electronic Amplifiers

These are also called thyratron drive systems because they use gas-filled tubes called thyratrons. In addition to rectifying, or changing ac to dc, the time during which the thyratron allows current to pass can be easily controlled.

Control element in a thyratron is the grid. A small amount of power at the grid controls much larger amounts of power passing between the cathode and plate, or anode, of the tube. Control is achieved by applying a positive potential to the grid of the tube at some moment during the time when the ac potential applied between plate and cathode is positive. The time at which the grid potential goes positive determines when the tube fires and the duration of current flow. Once the tube fires, it conducts until the plate-cathode potential goes to zero. No amount of variation in grid potential can effect a change in conduction characteristics of the thyratron once it fires, Figure 3.

FIG. 3. THYRATRON FIRING occurs during positive half cycle of plate-cathode voltage when grid potential goes positive.



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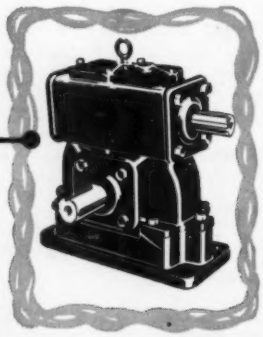

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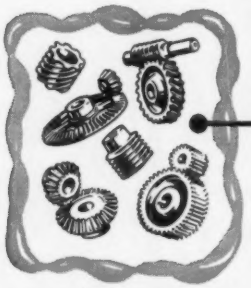

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For more information circle No. 1 on the Reader Service Card

automatic control and easy jogging economical for any machine

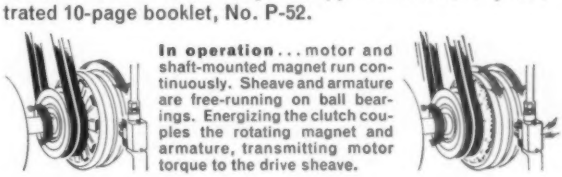
Warner's new Electro-Sheave

. . . adds all the benefits of electric motion control to any motor-driven machine at a practical price.

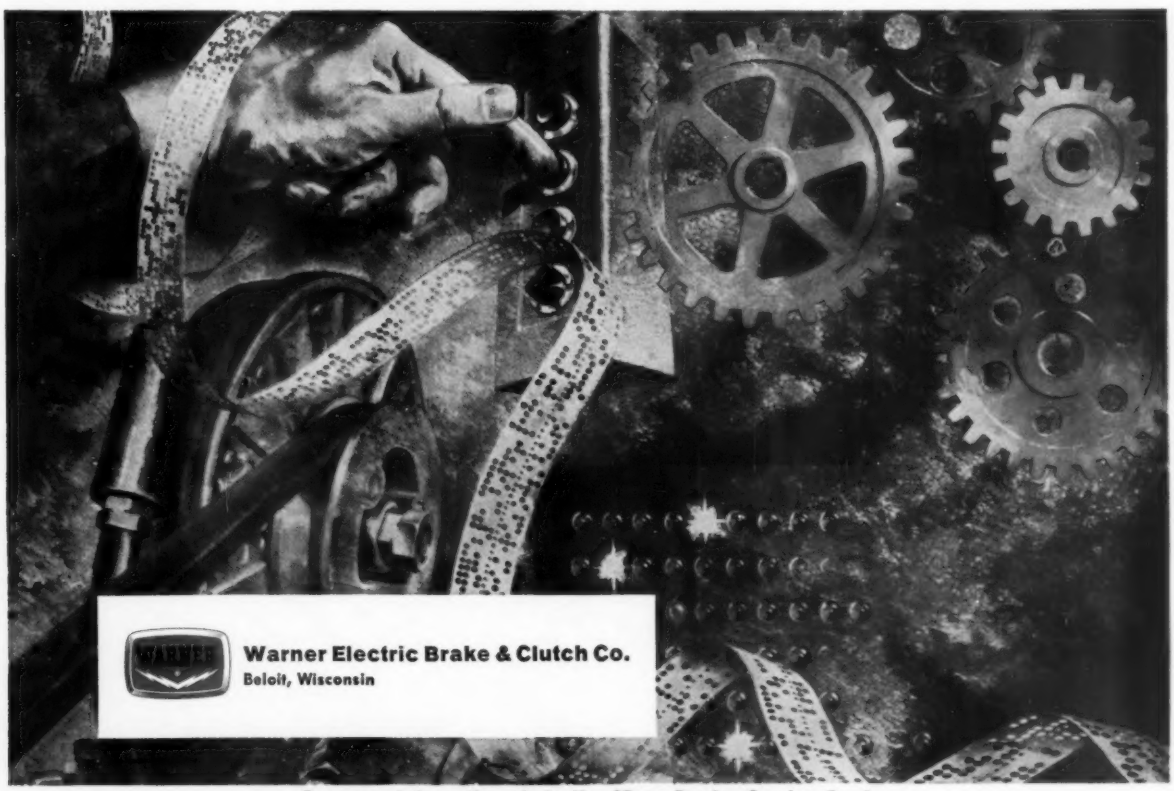
Warner's new combination clutch-pulley package saves you money two ways: 1) It comes to you off the shelf, in one, low-cost, precision assembly. You mount it directly to any standard NEMA motor shaft (new or old)—there is no engineering, machining, or alignment to worry about. Just slip it over the motor shaft, tighten a setscrew, mount the brushholder, belt the sheave to the machine and it's ready to go—in minutes. 2) It simplifies control. Any switch actuates the clutch. Simple wiring to the control panel and brushholder reduces assembly costs, eliminates mechanical linkages, levers, solenoids, and other actuating hardware.

The Electro-Sheave fits right into your design scheme—gives your machines such advantages as faster no-load starting, precise inching and jogging, adjustable torque, automatic control, smaller drive motors, reduced power consumption, and longer motor life. Five sizes (1 to 25 hp) are now available from all Warner distributors. Sheave sizes and styles accommodate most power requirements.

For complete information on installation and operation, including cutaway drawings, description of controls, and selection charts—send for your copy of the new, fully illustrated 10-page booklet, No. P-52.



In operation . . . motor and shaft-mounted magnet run continuously. Sheave and armature are free-running on ball bearings. Energizing the clutch couples the rotating magnet and armature, transmitting motor torque to the drive sheave.



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